CHAPTER 6

Shipping of the Indian Ocean World

Nick Burningham

The Arabian Sea Tradition

The Arabian Sea tradition has also been called the Arabo-Indian tradition[1] and the western Indian Ocean tradition. Arabo-Indian obscures the considerable Persian contribution to nautical technology and seafaring, while "western Indian Ocean" potentially subsumes the southern Indian, Maldivian and Swahili traditions, which we here treat separately.

Even with those traditions treated separately, the Arabian Sea tradition is a broad and heterogeneous grouping. Manguin says the ships of the "Arabo-Indian shipbuilding tradition […] obviously shared essential structural characteristics which led foreign witnesses to perceive them as one broad class of vessels".[2] It is this broad class of vessels to which the loosely defined term "dhow" is usually applied.

[1] Cf. Pierre-Yves Manguin (1985) "Late Medieval Asian Shipbuilding in the Indian Ocean", *Moyen Orient & Ocean Indien* 2.2, 1–30.

[2] Pierre-Yves Manguin (1985) "Asian Shipbuilding", 3.

N. Burningham (✉)
Western Australian Maritime Museum, Fremantle, WA, Australia

A. Schottenhammer (ed.), *Early Global Interconnectivity across the Indian Ocean World, Volume II*,
Palgrave Series in Indian Ocean World Studies,
https://doi.org/10.1007/978-3-319-97801-7_6

It is clear that the Arabian Sea shipbuilding tradition has long been a broad, cross-cultural tradition. Abū Zaid Hasan, al-Sīrāfī in the early tenth century (916) described how Omanis went to "the islands", probably the Lakshadweep (Laccadives) or Maldives, to build sewn-plank ships using coconut timber, coconut fibre twine and rope, and coconut frond matting sails, thus showing that an Arabian shipbuilding tradition was simultaneously located at the northern and southern edges of the Arabian Sea, and also providing evidence that Arabian ships of the time were sewn-plank constructed.[3]

The problem is to define the shared essential structural characteristics of the Arabian Sea tradition other than the sewn-plank construction, which has gradually been replaced by other construction techniques in all but some small craft constructed in remote locations. Another fairly uniform characteristic is an angular profile. These and other characteristics are discussed below.

Geographic Profile

The Arabian Sea tradition is found on the shores of the Arabian Peninsular, including the Red Sea and the Persian Gulf, on the coasts of Iran, Pakistan and India at least as far south as Malabar. Vessels belonging to this tradition have also been built on the East African coast; however, the Indian Ocean coast of Africa in Kenya and Somalia has its own tradition of shipbuilding.

Historical Profile

Seafaring and shipping in the Arabian Sea predate the shipbuilding tradition here identified as the Arabian Sea tradition. The oldest evidence for shipping anywhere in the Indian Ocean region, and the world, is the Magan ships trading to Oman's Arabian Sea coast circa 3000 BCE. They are thought to have been reed boats.[4] Perhaps the reed boats used by the Marsh Arabs of Iraq belong to the same tradition.

The author of the Periplus of the Erythrean Sea (first-century CE) tells us that the watercraft of the region were of sewn or lashed

[3]Translation in William Facey and Michael Rice (1991) *Oman: A Seafaring Nation* (Sultanate of Oman: Ministry of National Heritage and Culture), 107–108.

[4]Serge Cleuziou and Maurizio Tosi (1994) "Black Boats of Magan: Some Thoughts on the Bronze Age Water Transport in Oman and Beyond from the Impressed Bitumen Slabs of Ra's al-Junayz", in Asko Parpola and Petteri Koskikallio (eds.), *South Asian Archaeology 1993*, vol. 2 (Helsinki: Suomalainen Tiedeakatemia), 745–761.

construction. He does not state that Indian, Arabian or Persian ships were engaged in long-distance trade. Only the Roman ships trading to and from India are noted. However, Indian literature of the period does contain accounts of long sea voyages.[5] These accounts are clearly not factual in their detail, but they would not have been written if voyaging to distant lands was unknown. Strabo (early first-century CE) gives us Poseidonius' account of a shipwrecked Indian sailor who showed Eudoxos (between 345 and 338) the sea route to India.[6] Strabo thought the story complete rubbish including the idea that the Indian could have been the sole survivor of a ship that was bound for the Persian Gulf yet was driven to the west by adverse winds, but he did not question the idea that Indian navigators were voyaging to the Persian Gulf.

In the fourth century, the Latin historian Ammianus Marcellinus (d. c. 395 CE) reports that "all along the coast [of the Persian Gulf] is a throng of cities and villages, and many ships sail to and fro".[7]

Persian shipping is known to have been trading to China by the eighth-century CE.[8] It is difficult or impossible to distinguish Persian from Arabian activity in early maritime trade with China. The Chinese used the words Bosi 波斯 and Dashi 大食 to refer to people from Iran and Arabia. Both words are derived from names of Persian regions or ethnicities, but the meaning of Dashi shifted over time to Arabia and Arabian people.

Direct trade with China seems to have been replaced at least partly by a system in which ships from the Arabian Sea loaded cargoes of Chinese products at ports on the Isthmus of Kra in the late ninth century following the massacre of some 120,000 Muslims, Jews and Parsees at Guangzhou in 878/79.[9]

[5] Dieter Schlingloff (1988) *Studies in Ajanta Painting: Identifications and Interpretations* (Delhi: Ajanta Publishing), 196.

[6] Strabo [64/63 BCE–24 CE] (1917) *The Geography of Strabo*, vol. 1, Book 2 (Loeb Classical Library Edition), 378.

[7] Marcellinus Ammianus [325/330–c. 395] (1978) *Ammiani Marcellini rerum gestarum libri qui supersunt*, ed. Wolfgang Seyfarth, Liselotte Jacob-Karau, and Ilse Ulmann, vol. 1, Book 23, Chapter 6, Section 11 (Leipzig: B. G. Teubner).

[8] Geoff Wade (2012) "Southeast Asian Islam and Southern China in the Fourteenth Century", in Geoff Wade and Tana Li (ed.), *Anthony Reid and the Study of the Southeast Asian Past* (Singapore: ISEAS), 128.

[9] André Wink (1990) *Al-Hind, the Making of the Indo-Islamic World 1: Early Medieval India and the Expansion of Islam Seventh–Eleventh Centuries* (Leiden and New York: E. J. Brill), 84.

By the twelfth century, there were three segments to Indian Ocean trade: The Arabian Sea, the Bay of Bengal and the South China Sea. Arabs and Persians traded mainly in the Arabian Sea region, while the trade across the Bay of Bengal was largely conducted by Indian Muslims, particularly Gujaratis.[10]

For much of the last millennium, the main geographic trading range of Arabian Sea shipping has been to the Isthmus of Kra and the nearby Nicobar and Andaman islands in the east, and to the East African coast on the western side of the Indian Ocean. Aside from trade with East Asia, the trade triangle of India, Arabia and East Africa has been very important to the shipping of the region. Although the Arab dhows engaged in this trade have tended to excite most comment, photographs of dhows in ports such as Mombasa and Muttrah in the first half of the twentieth century indicate that Indian vessels have carried much of the trade. This might have been the case for several centuries. Statistics are not much available, but Agius offers the judgement:[11]

> It would not, therefore, be an exaggeration to say that Indians were, at the time of the coming of the Portuguese, masters of the Indian Ocean triangle trade not only as pilots but also as merchants.

When Portuguese ships reached the region, at the end of the fifteenth century Gujarati shipwrights were the most proficient and respected shipbuilders according to Portuguese observers. The ships they built were larger than other ships of the region and were seen to be well built.

In the eighteenth century, the British East India Company recruited shipwrights from Surat in Gujarat to set up and run the Company's shipyards at Bombay. Initially, their work was repair of EIC ships and construction of "country ships" for the intra-Asia trade. The shipwrights from Surat were Parsis. They adopted British shipbuilding designs and structures very successfully. The large Arabian and Persian dhows of the nineteenth century and the first half of the twentieth century, built with high ornamented sterns, sometimes said to illustrate Portuguese

[10] Michael Pearson (2010) "Islamic Trade, Shipping, Port-States and Merchant Communities in the Indian Ocean, Seventh–Sixteenth Centuries", in Michael A. Cook (ed.), *New Cambridge History of Islam*, vol. 3 (Cambridge: Cambridge University Press), 322.

[11] Dionisius A. Agius (2008) *Classic Ships of Islam: From Mesopotamia to the Indian Ocean* (Leiden: E. J. Brill), 182.

influence, were based on a design developed in these Anglo-Parsi shipyards of Bombay and Coromandel.[12]

Main Distinguishing Features of the Arabian Sea Tradition

Because the region is culturally heterogeneous, it is difficult to find shared essential structural characteristics of the Arabian Sea tradition to which there are no obvious exceptions and variations.

In general, the ships of this tradition have had a longitudinal profile with a straight or nearly straight stem which rakes fairly sharply forward, a straight keel and a straight sternpost which is often vertical or even raked inboard (Fig. 6.1).

Sewn-plank construction is an often noted and obvious characteristic, though it has been replaced by other construction techniques. Many vessels are single-masted with the mast stepped near midships, and when there is a second (mizzen) mast, the mainmast is still positioned near midships. The tall and (nearly) triangular lateen sail has often been cited as a consistent feature of the Arabian Sea tradition: It is however an historically recent development, and the sail type is actually the settee sail, not the triangular Mediterranean lateen which is a sail of greater antiquity.

In constructing the hull, the first row of planks (garboard strake) is fitted to the top surface of the keel. In recent practice, the garboard strakes are fitted into grooves cut in the upper surface of the keel. Because the garboards are fitted to the upper surface of the keel, they usually rise fairly steeply giving a sharp-bottomed cross-sectional shape; however, there are arrangements for creating a nearly flat bottom in which the keel is replaced by a broad median plank.

Planks are cut using saws and bent to shape. Soaking and the sun's heat are used to render the planks pliable. It is possible that heat from fires has long been used to bend planks in India. Traditionally, the construction sequence is plank-first. This is more or less necessary when the planks are sewn together. Hulls are strengthened by frame timbers, not necessarily articulated to form full frames, and by beams or thwarts (transverse timbers), which may project through the plank-shell.

[12] Nick Burningham (2007), "Baghla, Ghanja and Kotia: Distinguishing the Baghla from the Suri Ghanja and the Indian Kotia", *International Journal of Nautical Archaeology* 36.1, 91–111.

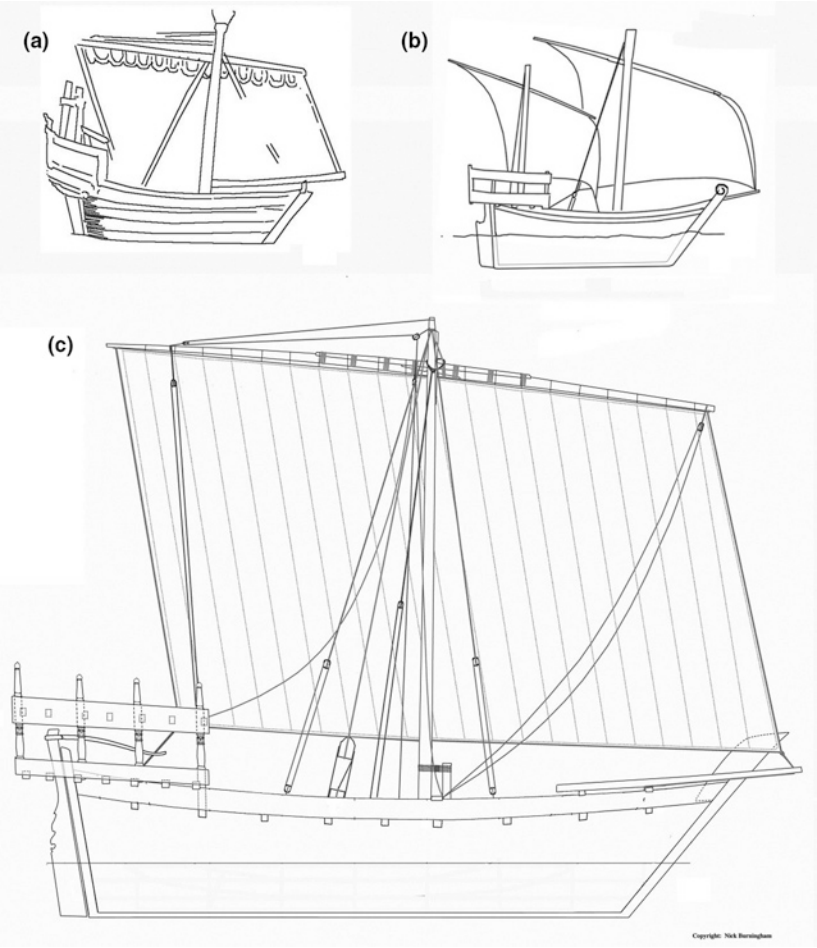

Fig. 6.1 Late-medieval Arabian Sea ships: (a) the Bhuj bas-relief, fourteenth century (?); (b) from the Miller Atlas, early sixteenth century; (c) reconstruction of typical late-medieval Indian ship

Some authors have contended that Arabian Sea ships had no frames prior to European arrival. This can now be rejected with confidence—the Belitung wreck (a ninth-century Arabian Sea ship) has frames spaced at about 330 mm between centres, which is reasonably close.[13]

[13]Michael Flecker (2000) "A Ninth-Century Arab or Indian Shipwreck in Indonesian Waters", *International Journal of Nautical Archaeology and Underwater Explorations* 29.2, 199–217.

Gazpar Correa (c. 1492–1563) states that the sewn-plank ships of Angediva and Cananor had frames, though only a few of them and that they were sewn to the planks.[14]

Changes to and Replacement of Sewn-Plank Construction

On the evidence of the Belitung shipwreck and medieval Indian iconography, it seems that the original sewing technique used wadding under the sewing both inside and outside the hull and produced an identical stitching pattern inside and out (Fig. 6.2). In recent times, that sewing technique has only been found in southern India. It has been replaced in Arabia and India by a technique in which wadding is only used on the inside and only vertical stitches appear on the outside. In some cases, the external stitches are let into grooves carved into the planks, probably so that the stitching is not damaged by abrasion when rubbing against other vessels when alongside in modern harbours.

Several of the early accounts of western Indian Ocean maritime activity by Portuguese chroniclers mention the sewn-plank construction and lack of iron fastenings in the early sixteenth century. However, there is evidence that some large ships of the region were no longer of sewn-plank construction. Manguin discusses the possibility of iron nail fastened ships in the Indian Ocean in the fifteenth century and points to four textual references to the use of nails in shipbuilding at the beginning of the sixteenth century.[15]

Two well-known thirteenth-century representations of ships by Yaḥyā b. Maḥmūd al-Wāsiṭī (*fl.* 1237) illustrating a manuscript of the *Maqāmat al-Harīrī* are said to show sewn-plank construction (Fig. 6.3). What they seem to show is stitched planks. There are pairs of stitches shown with spaces between the pairs of stitches. This is different to the tradition of continuous criss-crossed sewing over wadding. One of the illustrations shows the paired stitches crossing the seams vertically, while the other shows the pairs crossing each other diagonally. In recent times,

[14] Quoted in Pierre-Yves Manguin (1985) "Asian Shipbuilding", 4.

[15] Pierre-Yves Manguin (1985) "Asian Shipbuilding", 10.

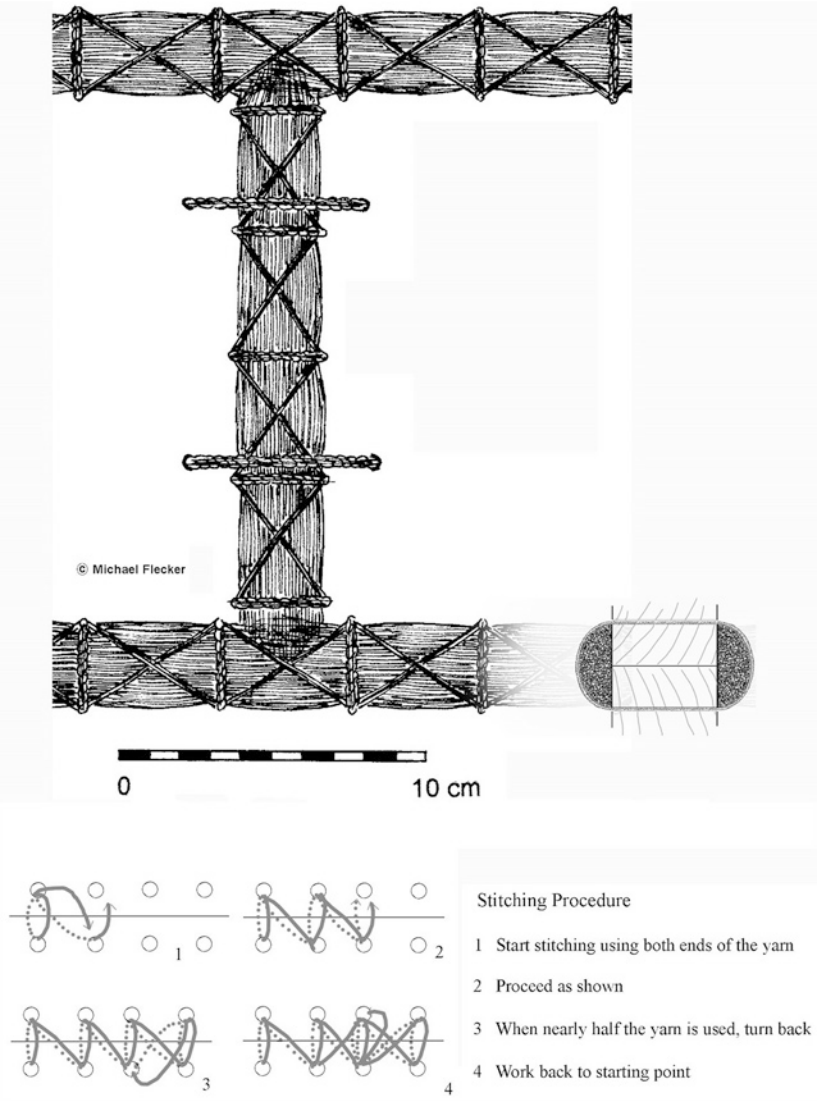

Fig. 6.2 Sewing pattern of Belitung Wreck (courtesy of Michael Flecker) and a stitching sequence to produce such a pattern

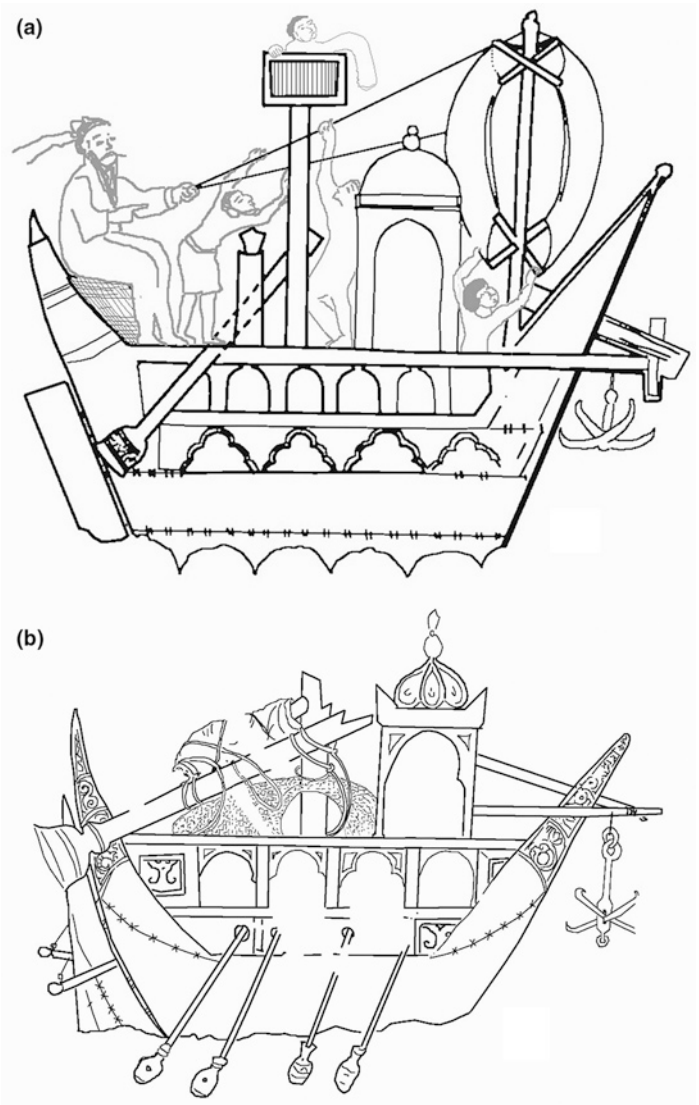

Fig. 6.3 Sea-going Persian/Arabian ships drawn by al-Wāsiṭī illustrating the Maqāmats of al-Hariri, circa 1235: (a) a Persian ship carrying passengers—only the crew who are working the rigging have been drawn in this tracing; (b) a ship about to sail from Oman, the mast is lowered. The tracing has been flipped horizontally to align with 6.3a

a similar system of paired stitches has been used to draw together the planks before fastening to the frames.[16] It is reasonable to suppose that this apparent change from continuous sewing in which there are multiple stitches through all of the closely spaced stitch holes, to a system of spaced pairs of stitches, reflects some other development which rendered the sewing together of the planks structurally less important. In relation to this, at the beginning of the sixteenth century when Portuguese shipping first reached the Indian Ocean and European mariners first recorded observations of Arabian Sea shipping, the ships of Gujarat were seen to be much larger than other ships of the region and wider ranging in their trade. Manguin proposes that the "average trading Gujarati vessel would have been somewhere around 300–600 tons" and mentions the ship *Meri* "belonging to the Sultan of Gujarat [and] taken [by the Portuguese] in Hormuz in 1510, could run to as much as 800 tons […]".[17] The loads on the hulls of such large vessels during launching, beaching and voyaging would be of significantly greater magnitude than the loads on the relatively modestly sized sewn-plank vessels from other regions, which implies some important differences in construction.

Although nails were used in some parts of India, the anonymous chronicler of Cabral's voyage explicitly states that no nails were used in Gujarati ships, which were "very well built, with excellent timber, and nicely sewn with ropes".[18] The most likely difference in construction is rabbeted plank seams, as proposed for large Gujarati vessels by Manguin.[19] A bas relief on a palliya stone dated late fourteenth or early

[16] Cf. for example Jeremy N. Green (2001) "The Archaeological Contribution to the Knowledge of the Extra-European Shipbuilding at the Time of the Medieval and Modern Iberian- Atlantic Tradition", in Francisco J. S. Alves (ed.), *Proceedings International Symposium on Archaeology of Medieval and Modern Ships of Iberian-Atlantic Tradition: Hull Remains, Manuscripts and Ethnographic Sources: A Comparative Approach: Centro Nacional de Arqueologia Náuticae Subaquática/academia de Marinha Lisboa*, 7–9 September 1998 [Trabalhos de Arqeologia, 18] (Lisboa: Instituto Portugês de Arqueologia), 66.

[17] Pierre-Yves Manguin (1985) "Asian Shipbuilding", 9.

[18] William B. Greenlee (1938) *The Voyage of Pedro Álvares Cabral to Brazil and India* (London: Hakluyt Society), 65.

[19] Pierre-Yves Manguin (1985) "Asian Shipbuilding", 9–10.

fifteenth century, now in the Bhuj Museum, Gujarat, shows a ship with plank seams but no obvious wadding or stitching on those seams.[20]

The earliest clear evidence for rabbeted seams is in a letter written in the mid-seventeenth century.[21] It was standard then and might have existed for many centuries previous. The technique was known from Gujarat and south as far as Bombay in the twentieth century.[22]

Rabbetted seam construction (*vadhera*) was probably brought to Bombay from Surat by the shipwrights who were recruited to work for the British East India Company in 1736, led by Lovji Nusserwanjee Wadia (Wadia or Vadia means shipwright in Gujarati). The ships produced by Lovji and his sons, grandsons and other descendants in several yards were highly regarded for their quality of build and longevity. A Mr Maconochie at the beginning of the nineteenth century reported about them:

> The bottoms of these ships are half as thick as those of the same kind built in England, the planks are rabbetted to the second or third plank above the bands [wales].[23]

John H. Grose, who visited the region half a century earlier, wrote:

> At Surat too they excel in the art of shipbuilding. If their models were as fine as English, of whom especially they prefer the imitation, there would be no exaggeration in averring, that they build incomparably the best ships in the world for duration, and that of any size, even to a thousand tons

[20] A photograph of this is reproduced in Jean Deloche (1994) "Iconographic Evidence on the Development of the Boat and Ship Structures in India (2nd cent. B.C.–15th cent. A.D.)", in Himanshu P. Ray and Jean-François Salles (eds.), *Tradition and Archaeology: Early Maritime Contacts in the Indian Ocean: Proceedings of the International Seminar Techno-Archaeological Perspectes of Seafaring in the Indian Ocean Fourth Cent. B.C.–Fifteenth cent. A.D. New Delhi, New Delhi, 28 Feb–4 March* (New Delhi: Manohar Publishers and Distributors), 221.

[21] Jean Deloche (1987) "Etudes sur la Circulation en Inde, vol. 7: Konkan Warships of the Eleventh–Fifteenth Centuries as Represented on Memorial Stones", *Bulletin de l'École Francais d'Extrême-Orient* 76, 165–184.

[22] James Hornell (1930) "The Tongue and Groove Seam of Gujarati Boat Builders", *Mariners' Mirror* 16, 310.

[23] Quoted in Ruttonjee A. Wadia (1957) *Bombay Dockyard* (Bombay: no publisher), 189.

> and upwards … the reign of their ships is much longer than that of the European built ones; it is not uncommon for one of them to last a century, and that not owing to the commonly summer seas in those parts, as to the solidity of the workmanship, and the nature of the wood they employ. As to the first, their bottom and sides are composed of planks let into one another, in the nature … of rabbit [rabbet or rebate] work, so that seams are impenetrable.[24]

The longevity of Bombay-built ships is demonstrated by HMS *Trincomalee*, launched in 1817 and still afloat, and HMS *Cornwallis* launched in 1813 and broken up 144 years later still reasonably sound.

Iconography

The iconography of second millennium CE, Arabian Sea shipping is relatively plentiful and fairly consistent in the kind of design portrayed. Reviews of the available iconography have been published by Nicolle (1989) and concentrating on the Indian iconography Schlingloff (1988) and Deloche (1987, 1994).[25]

Jean Deloche has advanced an unorthodox interpretation based on clear iconographic evidence. Most of the bas-relief representations of Indian ships from fourteenth century onwards (and some earlier) appear to have square or transom sterns.[26] It has been generally assumed that the Portuguese introduced the transom stern to the Indian Ocean, despite the fact that the transom stern was probably unknown in Europe

[24] John H. Grose (1772) *A Voyage to the East Indies: Containing Authentic Accounts of the Mogul Government in General, the Viceroyalties of the Decan and Bengal, with Their Feveral Fubordinate Dependances of Angria, the Morattoes, and Tanjoreans of the Mahometan, Gentoo, and Parsee Religions of Their Customs and Antiquities, with General Reflections on the Trade of India of the European Settlements, Particularly Those Belonging to the English, Their Respective Factories, Governments, Trade, Fortifications and Public Buildings; the History of the War with the French from 1754 to the Conclusion of the General Peace in 1763*, 2 vols (London: S. Hooper), 142–143.

[25] David Nicolle (1989) "Shipping in Islamic Art: Seventh through Sixteenth Century AD", *American Neptune* 49.3, 168–197; Dieter Schlingloff (1988) *Studies in Ajanta Painting*; Jean Deloche (1987) "Études sur la circulation en Inde"; Jean Deloche (1994) "Iconographic Evidence".

[26] Jean Deloche (1994) "Iconographic Evidence", 208.

when the Portuguese first sailed to the Indian Ocean.[27] Until the sixteenth century, all European ships were built with double-ended hulls—both the bow and the stern were sharp or rounded. Both ends of the strakes (rows of hull planks) ended on the median timbers called the stem and the sternpost in English. It has been assumed that the same was true of Arabian Sea ships. However, the Indian iconography seems to show square sterns in which the upper strakes run to a flat transverse aft end of the hull (a transom), which sits on the sternpost. It cannot be determined whether these square sterns were built with the structure known as a "square tuck stern" or a transom stern, or an "Arabian tuck stern".[28] It is possible that the ships were technically double-ended but built with a very full round stern as some Konkan coast *pattimar* were in the nineteenth and twentieth centuries.

The iconography shows the early introduction of the sternpost-mounted rudder in the Arabian Sea region. There is no known iconography from the seventh to tenth centuries. An Arabian-Persian work on astronomy entitled *Kitab suwar al Kawakib* (*Book of images of the fixed stars*) drawn by 'Abd al-Rahman al-Sufi (Azophi) around 964 contains an illustration of the constellation called the ship, which shows a ship with a curved bow profile and a vertical stern, and with a narrow rudder hung on the sternpost.[29] There is no sign of quarter-mounted rudders though there are two oars with their blades hanging below the hull from forward of midships. This seems to be because the constellation was originally understood as a ship with quarter rudders—a twelfth-century version of the *Kitab suwar al Kawakib* includes an illustration in which the quarter rudders are retained, but there is also a median rudder hung on the stern.[30] Two twelfth-century bas-relief depictions of ships at Goa clearly show sternpost-hung rudders.[31] The earliest known depiction of a sternpost-hung rudder in Europe is on

[27] Cf., for example, James Hornell (1918–1923) "The Origins and Ethnographic Significance of Indian Boat Designs", *Memoirs of the Asiatic Society of Bengal* 7.3, 236–238; Basil Greenhill (1976) *The Archaeology of the Boat* (London: A & C Black Publishers), 147.

[28] This term was coined in Nick Burningham (2007) "Baghla, Ghanja and Kotia", 100.

[29] David Nicolle (1989) "Shipping in Islamic Art", Figs. 6 and 7.

[30] David Nicolle (1989) "Shipping in Islamic Art", Fig. 8.

[31] Jean Deloche (1987) "Études sur la circulation en Inde", Figs. 7a and 8.

a font in Winchester cathedral. It is believed to have been made about 1180.

The European version of the sternpost-hung rudder used iron pintle and gudgeon (hinges). It was robust, but not optimally efficient. In the Arabian Sea region, iron pintle and gudgeon were not used. Rudders were secured by ropes in a manner that retained some of the advantages of the old quarter-mounted rudders. In some cases, rudders were devised so that the blade projected below the hull when in use. This allowed them to operate in "clean water", relatively undisturbed by the passage of the ship's hull through the water. It was thus necessary that the rudder could be raised or unshipped in shallow water and before beaching. A rudder, which projected below the hull, fairly deep into the water, would have positive buoyancy and float up unless there was also a large part of the rudder's weight above the waterline. This was achieved by extending upwards the sternpost from which the rudder hung. The sternpost was also extended aft by sewing on extra pieces of timber (called *fashin* in Arabic) and stiffened by cheek timbers. When in use, the forward edge of the rudder was fitted between the port and starboard cheek timbers to hold it in line with the sternpost and hull. The advantage of this arrangement was that the heavy loads on the rudder at sea were not transmitted directly to the sternpost and sewn-plank hull. The rudder was pulled forward between the cheek timbers by ropes port and starboard. The rudder was also controlled, to steer the vessel, by two more ropes also led to the stern of the ship (Fig. 6.4). The presence of these two pairs of lines with different functions, running nearly parallel, has been the cause of some confusion and ambiguity in descriptions of the steering arrangements, as observed by Manguin.[32] The rudder could also be secured by simply lashing it to the sternpost or the *fashin*.

Change of Sail and Rigging in the Iconography

It is widely stated and accepted that the triangular lateen sail, or a similar sail shape with a short luff called the settee sail, is the traditional and

[32] Pierre-Yves Manguin (1987) *The Trading Ships of the South China Sea*, Joint Conference of the Australian Association for Maritime History and Australian Institute for Maritime Archaeology (Nedlands: University Extension, University of Western Australia), 7.

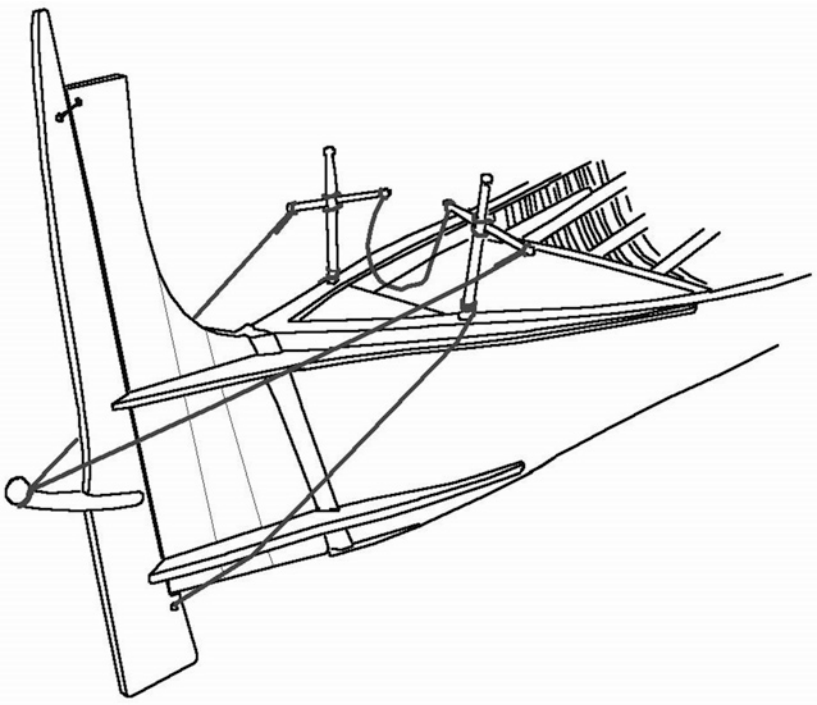

Fig. 6.4 The stern of a small Omani vessel, a *baqara*, showing the rudder hung from the sternpost extension (*fashin*), the aft-pointing tiller controlled by yoke-lines led to levers fitted to stanchions port and starboard, and separate lines pulling the rudder forward into the fork created by cheek timbers

ancient sail of the Arabian Sea region.[33] However, most pre-modern iconography shows square sails.

Arabian Sea sails have a yard on the upper edge (head) but usually no boom on the lower edge (foot). However, if some type of matting was used for sails in the past (rather than strong woven cloth), a boom would have been necessary.

It should be noted that "square sail" is not a description of sail shape. A sail triangular in shape can be a square sail. Square sails lie square to

[33]Cf. George F. Hourani (1951) *Arab Seafaring in the Indian Ocean in Ancient and Early Medieval Times* (Princeton: Princeton University Press), 100–101.

(90° to) the fore-and-aft line of the vessel. They can be braced to lie close to the fore-and-aft line when the wind direction is around right angles to the ship's course or further ahead. Either of a square sail's two (approximately) vertical edges can be the leading edge or "luff".

In late-medieval and early-modern iconography, there is evidence of rectangular sails set as fore-and-aft sails—with one edge always the luff or leading edge and the other edge the leach or trailing edge.

Deloche drew attention to the bas-relief from Bhuj, Gujarat, thought to be fourteenth century, which is the earliest clear illustration of a quadrilateral sail set as a fore-and-aft sail. The tack is held forward by a boom, and there is a lift to peak up the aft end of the yard. The yard aft of the mast is longer than the yard forward of the mast whereas a square sail is always set symmetrically with equal parts either side of the mast. The sail is more or less rectangular and thus the same shape as earlier square sails.[34]

Correia, in the early sixteenth century, described sails which were no longer rectangular,[35] the yard extended aft of the mast further than forward of the mast and:

> The sail is longer [i.e. greater in height] aft than forward by one-third … [the rig is configured to] bring the sail [i.e. the tack] very far forward, so that they steer very close to the wind …

Over the following centuries, the leading edge became shorter and the trailing edge of the sail longer. It was not until the second half of the nineteenth century that the nearly triangular settee sail was common on the Arabian Sea. On the evidence of limited iconography and ethnographic record, it seems to have spread from southern India and the Malabar coast.

The change from square sails to fore-and-aft sails was probably made at different times in various regions of the Arabian Sea. Whether the Arabian Sea ships depicted on the 1511 Lopo Homem/Reinel atlas carry square sails, or rectangular fore-and-aft sails like the Bhuj ship is open to debate. The tack of the mainsail is held forward by a bowsprit or

[34] Jean Deloche (1994), "Iconographic Evidence", 221.

[35] Gaspar Correa [c. 1492–1563] (1869) *Three Voyages of Vasco da Gama and his Viceroyalty: From the Lendas da Índia of Gaspar Correa*, trans. Henry E. J. Stanley (London: The Hakluyt Society), 239–241.

a moveable boom. The yards are slightly peaked up aft. The yards seem to lie fore and aft when the sails are furled. These details suggest sails set fore and aft. On the other hand, the yards are symmetrically set on the masts—equal lengths either side of the mast. There is no depiction of the lift (rope), which could peak up the yard if it were set fore and aft, but neither are there the braces that control the yard of a square sail. The depictions are finely executed, but they are miniatures, so some lack of detail is unsurprising. The lack of a lift might not indicate a square sail: Many nineteenth-century and twentieth-century Indian dhows rigged lifts to peak up the yards of their settee sails while Arabian dhows never did.

In historically recent times, the masts of Arabian Sea ships were usually stepped so that they could be easily lowered. Arabian dhows routinely lowered their masts and dropped them overboard before beaching. Indian dhows did not. In both cases, the mainmasts were lashed to a stout pole (*abd* in Arabic) just forward of the mast. The mainmast was stepped at the forward end of the long and narrow main hatch, which served to restrain lateral movement of the mast when it was being lowered and raised.

The drawing of a ship by al-Wāsiṭī illustrating the 39th Maqāmat of al-Harīrī might show that a similar arrangement was used in thirteenth century if we allow that al-Wāsiṭī was no mariner and did not fully understand ships' rigs (Fig. 6.3b). (I suspect he mischievously misrepresented them.) The mainmast is lowered in al-Wāsiṭī's drawing and the heel of the mast is loosely lashed to a short upright like an *abd*. The shape of the heel of the mast and the top of the proposed *abd* suggest that the mast will be scarfed to the top of the *abd*, which would be a very frail arrangement. Perhaps a seaman had explained to al-Wāsiṭī that the mast would be secured to the *abd* and al-Wāsiṭī had incorrectly inferred how that would be done. The interpretation that the mast is broken off a couple of metres above deck level is not correct. The ship is shown at the moment of setting off on a voyage and the protagonist of the Maqāmats, Abū Zaid al-Balkhī (b. 850), is asking to take passage onboard. There appears to be a large matting sail around the foot of the mast/*abd* and a cloth sail, which has been furled to a spar. The more frequently reproduced al-Wāsiṭī drawing of a ship (Fig. 6.3a) also shows a mast hanging over the stern, though there are also two masts stepped (standing erect).

Shipwreck Archaeology

The ninth-century Belitung wreck is the only discovered shipwreck of this tradition. It was excavated under less than ideal circumstances but is, nevertheless, very informative.[36] The hull remains of the Belitung shipwreck were extensive and relatively intact. However, a considerable part of the hull remained covered by lime concretion and lead ballast embedded in the lime concretion at the end of the excavation. The hull remains were almost entirely flattened by the weight of the cargo.[37]

The keel was 15.3 m in length and straight. At the forward end, it was only 150 mm deep by 140 mm wide. It was larger in the stern and probably largest through the midbody of the hull.

The planking, which lay flattened on the seabed, extended 5.1 m to port of the keel and included two strakes above where the beam ends projected through the planking. The half girth of 5.1 m implies a very broad beam relative to length.

The stem raked forward 29° from vertical when the keel was horizontal.

The garboard strakes were sewn to the upper face of the keel with no bevel or rabbet on the keel. Similarly, there was no bevel or rabbet on the stem.

There was a substantial keelson, which was notched to fit over the frames.

The hull planking was about 40 mm thick and varied in width from 200 to 400 mm. Marks on the planks showed that the planks had been sawn (not cleft). The holes for the sewing together of the planks were spaced at about 50–60 mm. There was wadding under the sewing both inside and outside. Planks were butt-joined by sewing and two extra stitches. (It is the pattern of the sewing, which provides the strongest evidence that the ship was built in the Arabian Sea region tradition, although the wreck is in Southeast Asian waters, the cargo is from China and much of the timber probably came from Africa.)

Frames were somewhat irregularly spaced averaging about 330 mm between centres. Notches were cut in the frames to accommodate the wadding and sewing. Frames were stitched to the planking.

[36] Michael Flecker (2000) “A Ninth-Century Arab or Indian Shipwreck”.

[37] The following data are all from Michael Flecker (2000) “Shipwreck”.

The beams projected through the planking on the seam between the fourteenth and fifteenth stakes and grooves were cut in the beams to fit notches cut in the planks. Those grooves show that the fourteenth strake was flared at about 20° from vertical while the fifteenth strake was approximately vertical; thus, there was a kind of chine at the level of the deck beams.

No dowels were found anywhere in the construction. The stem was attached to the keel by a tenon and robust stitching, but the tenon was not locked. The entire structure was held together by the stitching. No other fastening system was involved.

There were loose dunnage planks in the inside of the frames. There were approximately 10 tonnes of lead ballast as ingots along the centre line of the hull, stacked on the keelson and dunnage planks.

Subsequent to Flecker's 2000 publication, hull planking and frames were identified as *Afzelia africana*, a species found in relatively arid parts of Africa. The beams were teak (*Tectona grandis*) probably from India.

During designing of a "replica" of the Belitung wreck, we were given access to all of Flecker's site photographs, drawings, field notes and videos, which revealed more detail in discussions between Michael Flecker, Tom Vosmer and Nick Burningham.

Although no sternpost was positively identified, the aft hood ends of two adjacent lower strakes were identified and showed that the sternpost was either vertical or raked slightly inboard. The sister keelsons extended further aft than the keelson (perhaps to create a bailing well) and close to the aft end of the keel. This implies that the lower hull in the stern was quite full (not sharp) relative to the bow.

Although the hull planking was flattened on the seabed, a number of details contributed to the conclusion that the vessel had sharp deadrise—a V-shape cross section. The keelson was lying well to port of the keel, and it was canted over at about 45°, which shows that the hull was lying heeled over at a large angle on the seabed. In the flattening of the plank-shell, the strakes were not torn apart in the bow and stern. This indicates that there was little taper and "sny" to the planking and is consistent with the kind of V-section shape achieved when something like an envelope is spread open. The way the garboard strakes were sewn to the upper face of the keel shows that the garboards rose fairly sharply from the keel. The presence of approximately ten tonnes of lead ballast at the bottom of the cargo contributes to the evidence for sharp deadrise. The lead might have been cargo, but it obviously served as ballast. A sharp

bottomed vessel needs some ballast to float upright. A hull form with considerable deadrise can incorporate the great girth but have relatively slight capacity and displacement—characteristics that are compatible, with the hull's light scantlings. The proposed design with considerable deadrise and flared topsides had a length-beam ratio of 2.66:1, but the length waterline to beam waterline ratio was a more reasonable 3.03:1. A hull with an approximately triangular cross section (like that of the East African *mtepe*) will resist cross-sectional deformation better than one with a more rectangular section. Sharp, hollow deadrise is a feature of a number of traditional Arabian designs including the *battil* and *zarooq*.

A number of these identified design features show consistency with Arabian Sea tradition of more recent centuries. These are the straight stem, keel and sternpost, the stem raked more than the sternpost, the hull form fuller in the stern than the bow, the garboard strakes fitted to the upper face of the keel, flared topsides, and the planking arranged with little taper and sny.

To provide the full shape low in the stern, necessary to accommodate the sister keelsons, the stern of the replica was shaped like that of Omani *battil* and *zarooq*, but that detail is speculative (Fig. 6.5).

Structural Performance of Arabian Sea Sewn-Plank Construction

Sewn-plank construction is often seen as frail and lacking rigidity. There are exceptions to this assessment. Manguin[38] says that Gaspar Correia showed himself to be a "far shrewder observer in those matters than most of his contemporaries" in his judgement that the sewn-plank vessels were "made as strong as if they had been nailed".[39] Sometimes the lack of rigidity or flexibility is cited as an advantage, particularly in boats that work from open beaches and are liable to damage when beaching through breaking waves. This is not quite correct. Boats such as Indian *masula* which work from open beaches are flexible because they have almost no frames. If they were not of sewn-plank construction, they would not only be flexible, but they would fall apart. Their advantage is that when they are damaged, they can be easily disassembled. Damaged

[38] Cf. Pierre-Yves Manguin (1985) "Asian Shipbuilding", 4.

[39] Gaspar Correa (1858–1866) *Lendas da India*, 8 vols (Lisbon: Academia Real das Sciencias), 1/1, 122 (according to Pierre-Yves Manguin (1985) "Asian Shipbuilding").

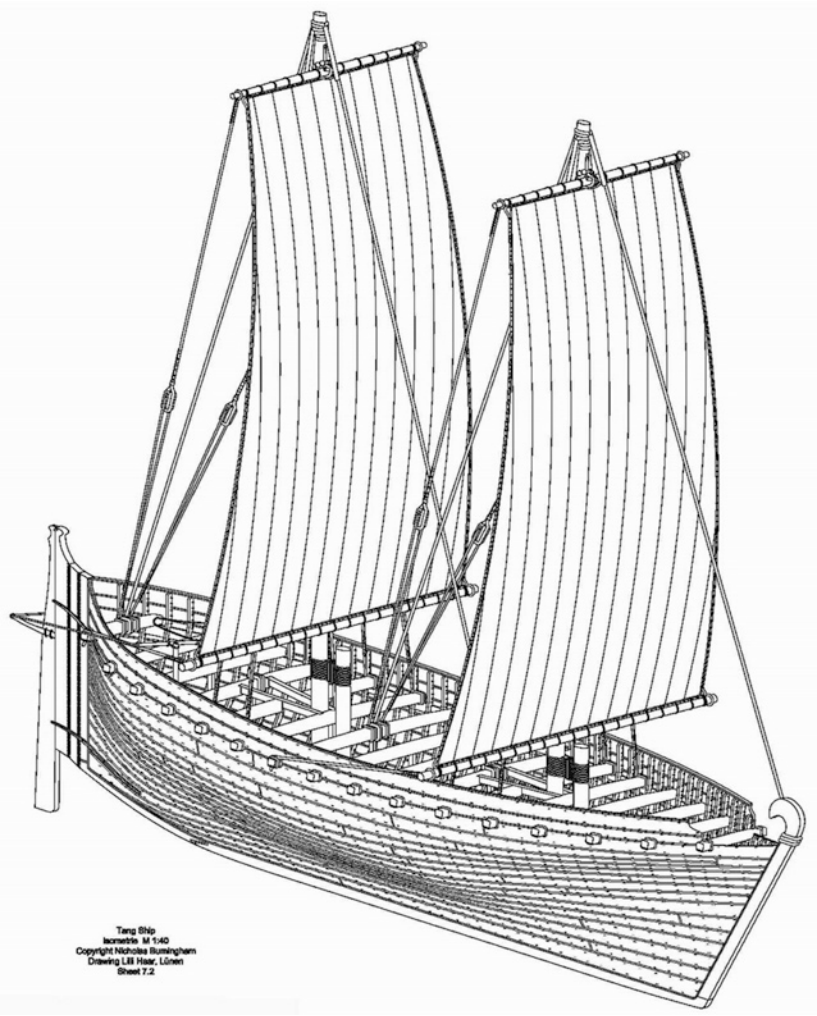

Fig. 6.5 Reconstructed design of the Belitung wreck, a ninth-century Arab/Persian ship showing the sharp V-section hull, beam ends protruding through the planking and a fashin-hung rudder. The use of square sails is uncontroversial, but the two-masted configuration is speculative

components are then replaced and the vessel reassembled with all the structural integrity of a new vessel.

Where there is adequate framing, beams and adequately thick planking, a sewn-plank vessel, such as the Belitung shipwreck replica *Jewel of Muscat,* is very rigid. It was observed when *Jewel of Muscat* was craned from the water in Singapore (having sailed there from Oman) with two slings around the hull, there was no distortion of the hull, no creaking or cracking sounds, and the keel remained perfectly straight. A conventionally constructed vessel would probably have shown distortion. An earlier sewn-plank reconstruction or replica vessel, *Sohar*, built in Oman in 1979–1980 and sailed to China[40] was shipped back to Oman and has been sitting in the middle of a traffic roundabout for three decades. She remains intact and apparently structurally sound.

The stitches of a sewn-plank vessel are made very tight. In the stitching pattern of the Belitung shipwreck, there are four stitches through every stitching hole, each one contributing to the tightness and rigidity. The planks are so tightly held together that the hull behaves as a monocoque.

The complete absence of any fastenings other than stitches in the Belitung shipwreck is noteworthy. Marco Polo observed that sewn-plank vessels at Hormuz had dowels or treenails in their construction. Manguin has speculated that the construction of large sewn-plank vessels would necessarily involve dowels.[41] That might be correct, but the use of dowels in the construction of non-sewn-plank vessels in Arabia in recent times has not included any systematic use of dowels. Dowels are sometimes used in a pragmatic or haphazard way, for example, to secure an end of a plank scarf to adjacent planking when there is no frame to fasten it to, or as a temporary fastening before a frame is fitted, but doweling or treenail fastening does not appear to be an integral part of Arabian Sea shipbuilding. Jerónimo Lobo (d. 1678) noted that the shipwrights of Hormuz "hammered several additional wooden pegs *wherever it was necessary*".[42]

[40] Tim Severin (1982) *The Sindbad Voyage* (London: Hutchinson Publishing Group).

[41] Pierre-Yves Manguin (1985) "Asian Shipbuilding", 4.

[42] Jeronimo Lobo (1984) *The Itinerário of Jeronimo Lobo*, translated from the Portuguese text by Lockhart, Donald M., established and edited by Costa, M. Gonçalves da, introduction and notes by Charles F. Beckingham (London: The Hakluyt Society), 107; emphasis added.

A disadvantage of sewn-plank construction is that the sewing must be replaced every few years—it is high maintenance construction. Because loads on the hull of a large ship are of greater magnitude than those on smaller vessels, there is an upper size limit for sewn-plank construction unless the structure is reinforced in some way. Because the coir rope used for sewing is stretched taut, significant distortion of the hull will result in failure (snapping) of the sewing.

Other Indian Traditions

Geographic Profile

Southern and eastern India has watercraft construction traditions that differ from the Arabian Sea tradition. The early iconography of Indian shipping does not show designs that accord with the Arabian Sea tradition.

The east coast of India presents natural impediments to the development of shipping. It is a lee shore during the north-east monsoon. During the south-west monsoon, it can be affected by tropical cyclones and severe squalls. There is evidence for the destruction of the major Cōḻa port of Pumpuhar (Kaveripattinam) in the eleventh century by a tsunami.[43] General silting and longshore drift of sand and sediment on the Tamil Nadu and Andhra Pradesh coasts closes the entrance to river mouths. Visakhapatnam, the only natural harbour on the east coast of India, employs large suction dredges to continuously carry sand across the harbour mouth.[44] A WWW survey of modern ports shows that they all require dredging to remain open.

Historical Profile

The history and importance of early seafaring in India is not well understood. Buddhism was spread to the Maldives by the Maurya Empire (322–185 BCE), which implies offshore seafaring had developed at a fairly early date.

[43] Rajendran, Chittenipattu P., *et al.* (2011) "Geoarchaeological Evidence of a Chola-Period Tsunami from an Ancient Port at Kaveripattinam on the Southeastern Coast of India", *Geoarchaeology: An International Journal* 26.6, 867–887.

[44] Anonym, Visakhapatnam, https://en.wikipedia.org/wiki/Visakhapatnam (accessed on 15 September 2013).

It seems likely that there was significant shipping on the southern east coast of India during the Cōḷa period. Literature of the Sangam Cōḷa period mentions ship types of southern India but provides no useful description.[45] In the eleventh century, a Cōḷa armada attacked Śrīvijaya, but a recent scholarly publication on this significant episode presents no clear information about the number, size or design of the ships involved[46] and there is no iconography to elucidate the question.

The entire east coast of India and the Bay of Bengal, including Kolkata (Calcutta) and the Ganges delta round to Pegu (now Bago) and the Gulf of Martaban can be distinguished as a region where there is no clear evidence for the construction and use of large sea-going watercraft. Barbosa described the shipping of Bengal, which was owned entirely by foreign merchants (Arabs, Persians, Gujaratis, Javanese and others):

> They are all great merchants, and own large ships of the same build as those of Mekkah, and others of the Chinese build which they call jungos, which are very large and carry a very considerable cargo. With these ships they navigate to Cholmender, Malabar, Cambay, Peigu, Tarnasari, Samatra, Ceylon, and Malaca; and they trade in all kinds of goods, from many places to others.[47]

Of the neighbouring north-western part of Myanmar, which he called "Berma", Barbosa wrote: "We have no further information respecting this country because it has no shipping".[48]

Early Iconography

No early Indian representations of watercraft show vessels that fit the Arabian Sea tradition as we have defined it. The vessels depicted on

[45] M. R. Raghava Varier (1988) "Marine Technology in Ancient Tamilakam", in G. Victor Rajamanickam and Yellava Subbarayalu (eds.), *History of Traditional Navigation* (Thanjavur: Tamil University), 51–62.

[46] Hermann Kulke, K. Kesavapany and Vijay Sakhuja, eds. (2009) *Nagapattinam to Suvarnadwipa: Reflections on the Chola Naval Expeditions to Southeast Asia* (Singapore: Institute of Southeast Asian Studies).

[47] Duarte Barbosa (1866) *A Description of the Coasts of East Africa and Malabar in the beginning of the Sixteenth Century*, trans. Henry E. J. Stanley (London: The Hakluyt Society), 179. Barbosa sometimes used "Chinese" to mean "oriental" including Southeast Asia: For example he wrote "There is much trade in cloves and mace and other Chinese goods…", though he knew precisely where cloves and mace came from.

[48] Duarte Barbosa (1866) *A Description of the Coasts of East Africa and Malabar*, 181.

Fig. 6.6 Fishing vessels on Lake Chilka, Andhra Pradesh, carrying sails which might be termed "battened square spritsails". The stiff, rectangular sails depicted in the sixth-century Ajanta mural might have been similarly devised

two second-century BCE ornamental reliefs at Bharhut, central India, second-century CE coins from Andhra Pradesh and the fifth- and sixth-century murals at Ajanta in central India all show vessels with curved bow and stern profiles and no evidence of stitched-plank construction. Indeed the two Bharhut boats are clearly shown to have their planks held together by double-dovetail timber straps (or "butterfly strap") let into the planking. Because Bharhut and Ajanta are so far from any coast the vessels depicted are not reliably associated with any particular region or tradition. The Ajanta ship could be a depiction of a Southeast Asian ship.

The Andhra ships have two masts of equal height and yards from which high aspect-ratio (tall and narrow) square sails were presumably set. The Ajanta ship has three masts and a bowsprit. All three masts are positioned towards the bow of the ship, probably because the person and superstructure in the stern are shown unrealistically large because of their narrative importance. The sails are quadrilateral and of high aspect-ratio, but the shifting of the masts towards the bow probably exaggerates the aspect-ratio. The sails appear stiff and flat, except for a small square sail set under the bowsprit, which is shown billowing with the wind. No yards, booms or battens are shown and the sails are not shown square to their masts. It is possible that the rig depicted is a type of rig still in use on inland waterways of Andhra Pradesh (Fig. 6.6). It is related to the simple spritsail used on Sri Lankan canoes in the way it is set and controlled.

Archaeology

The remains of a curious vessel were discovered some distance from the sea at Kadakkarappally, Kerala, in 2002. Timber samples were C14 dated to 920–1160, and 1020–1270 CE and construction is tentatively dated thirteenth century to fifteenth century.[49] It is not a sea-going ship: The completely flat-bottomed hull would have been used on the shallow inland waters of Lake Vembanad the shore of which now lies a few kilometres to the east. Some aspects of the construction are sophisticated and unlike anything seen elsewhere. Clenched iron nails, square-section wooden pegs and rope lashings were all used in fastening the hull components. Unless there is something not yet understood, it is not strong construction. There appears to be no edge-fastening of the planks, however there are two layers of planking.

Ethnographic Evidence of South and East Coast Indian Shipbuilding Tradition

An interesting aspect of the construction of the Kadakkarappally vessel is the chine strakes—carved L-section pieces that form the juncture of the flat bottom and the near vertical sides. This structure can be seen as deriving from the kind of split and expanded dugout canoe used until recently in Sri Lanka.[50]

Edye described the "Doni of the Coromandel coast" as a "vessel of ark-like form, about seventy feet long, twenty feet broad and twelve feet deep; with a flat bottom or keel-part, which at its broadest part is seven feet…"[51] His drawing shows a double-ended vessel with rounded bow and stern, designed more for capacity than speed, and with the flat bottom made from thick baulks or planks of timber. There is the possibility that the flat bottom of the "doni" recorded by Edye derived from the kind of split dugout structure seen in the Kadakkarappally vessel and Sri Lankan *madel paruwa*.

[49] Victoria Tomalin, *et al.* (2004) "The Thaikkal-Kadakkarappally Boat: An Archaeological Example of Medieval Shipbuilding in the Western Indian Ocean", *International Journal of Nautical Archaeology and Underwater Explorations* 33.2, 353–363.

[50] Eric Kentley (2003) "The Madel Paruwa of Sri Lanka: A Sewn Boat with Chine Strakes", in Seán McGrail (ed.), *Boats of South Asia* (London: RoutledgeCurzon), 167–183.

[51] John Edye [1789–1873] (1834) "Description of the Various Classes of Vessels Constructed and Employed by the Natives of the Coasts of Coromandel, Malabar, and the Island of Ceylon, for their Coasting Navigation", *Journal of the Royal Asiatic Society* 1.1, 1–14, plate 13.

Edye's Coromandel doni is clearly an earlier version of the type of vessel described by Hornell as the Jaffna dhoni. If Hornell was right, rather than Edye, these vessels traded to the Coromandel coast but were built on the Jaffna Peninsula of northern Sri Lanka.[52]

In recent times there is little evidence of traditional shipbuilding on the East coast of India and the Bay of Bengal though fine vessels of European design were built in the nineteenth and twentieth centuries. Hornell said that baggala and pattamar (dhows) were so cheaply operated that "true ships [of European design] were never able to compete with them on the West Coast". But on the East Coast and Bay of Bengal "a fine fleet of brigs, barques and dhonis" operated until replaced by steamers.[53] The dhonis were the Jaffna dhonis mentioned above, hailing from the northern tip of Sri Lanka.

The smaller Jaffna dhoni, according to Hornell,[54] "owes little or nothing to European contact", but the detail of his observations was less than accurate—Hornell said they were schooner rigged though his photograph and others clearly show an oddly proportioned ketch rig. He also describes them as having sharp stem and stern, though photographs show that some were rather bluff bowed and had full sterns.[55] Edye's drawing of a "doni" also shows very round bow and stern, and a flat bottom that Hornell was apparently unaware of. It seems possible that these smaller Jaffna dhonis were, like the larger ones, of largely European design. Folkard says the "dhoneys of Jafnapatam" were "fastened with nails and iron bolts".[56]

Hornell observed and described the development of a similar design of dhoni or thoni, which was based on the design of sailing lighters imported to Tuticorin (Thoothukudi) on the Indian side of Palk Strait at the beginning of the twentieth century.[57] Forty years later the Tuticorin *thoni* appeared to be a long-established traditional vessel type.[58]

[52] James Hornell (1943) "The Fishing and Coastal Craft of Ceylon", *Mariner's Mirror* 29.1, 49.

[53] James Hornell (1918–1923) "The Origins and Ethnographic Significance of Indian Boat Designs", 178.

[54] James Hornell (1943) "The Fishing and Coastal Craft of Ceylon", 49.

[55] James Hornell (1943) "The Fishing and Coastal Craft of Ceylon", 49.

[56] Henry C. Folkard (1870) *The Sailing Boat: A Treatise on the English and Foreign Boats*, 4th ed. (London: Longmans, Green & Co.), 316.

[57] James Hornell (1920) "The Origins", 157.

[58] Clifford W. Hawkins (1965) "The Tuticorin Thoni", *Mariner's Mirror* 51.2, 147–153.

The Swahili Tradition

Geographic Profile

Vessels of this distinct tradition were mainly built on the Kenyan coast. Similar construction was recorded to the north in Somalia (Chittick 1980). How widespread the tradition was in earlier times is unknown.

Historical Profile

Adams[59] quotes Vasco da Gama or his chronicler about the ships of Mozambique: "The vessels of this country are of good size and decked. There are no nails, and the planks are held together by cords … The Sails are made of palm matting. Their mariners have Genoese needles, by which they steer, quadrants and navigating charts".

Evidence from the sixteenth century to eighteenth century shows that ships from East Africa sometimes sailed as far as the Hadramawt, Oman and India.[60]

Nineteenth-century observers marvelled at the speed and windward ability of *mtepe*, which belied their rough and apparently primitive appearance.

The construction technique, recorded by ethnographers in the twentieth century, is different from the Arab-Persian tradition. It has some affinities with Southeast Asian and Maldivian traditions of shipbuilding. The hull planks are edge-doweled together. The best-known vessels of this tradition were the *mtepe* and *dau la mtepe* from the Lamu archipelago, Kenya, built by the Bajun (mangrove cutter) people.

Principal Characteristics

The construction of the Lamu vessels was misunderstood until the publication of Robert M. Adams' 1985 MA thesis. Hornell had said that the planks were skew-doweled with the dowels driven from below into the newly fitted plank. He was working from one model in the Science

[59] Robert M. Adams (1985) *Construction and Qualitative Analysis of a Sewn Boat of the Western Indian Ocean* (College Station: Texas A & M University), 12.

[60] Cf. Thomas Vernet (2015) "East African Travellers and Traders in the Indian Ocean", in Michael Pearson (ed.), *Trade, Circulation and Flow in the Indian Ocean World* (London: Palgrave Macmillan), 167–202.

Museum, not from actual observation of *mtepe*. Adams shows that other models are "tenon doweled" (i.e. edge-doweled). The science museum model is not well made.

> The actual method in which these planks [of *mtepe*] were fastened to each other was with dowel tenons set vertically between planks. The dowel tenons were not visible on a completed vessel.[61]

The dowelling was the primary plank-to-plank fastening. After the planks were dowelled together they were then sewn together with wadding on the inside of the seam. The stitching pattern was the same as that used in India and Arabia, however on *mtepe* tapered pegs were hammered into the stitch holes from the inside to lock the stitches, the projecting ends of the pegs and the stitching were adzed off on the outside of the hull. On the garboards and the hoodends, where pegs could not be fitted (because there is not enough space to wield a mallet) there was wadding on the outside and the stitches were not cut away. The same was true of vestigial hoodend sewing on Omani vessels such as *bedan*, which were largely nail fastened.

Chittick[62] shows the same edge dowel and sewing construction technique for Somali boats (which look much like Omani sewn-plank *kambari*).

Adams thought that the garboard strake (first row of planks) was fitted to a bevel on the keel (as in Southeast Asian and Maldivian vessels) but admitted that he could not be certain that the garboards were not fitted into a rabbet on the keel (in the European manner). Prins[63] shows a fairly broad and boat-shaped cross section to the keel, with the garboards fitted on top of the keel (as in the Belitung wreck).

Like the Belitung wreck, Maldivian *dhoni* and some types of Southeast Asian vessel, *mtepe* had very sharp deadrise.

Mtepe also had a keelson: A feature which they shared with the much earlier ninth-century Belitung wreck and tenth-century Cirebon wreck. The keelson is usually regarded as a relatively modern European

[61] Robert M. Adams (1985) *Construction and Qualitative Analysis*, 32.

[62] Neville H. Chittick (1980) "Sewn Boats in the Western Indian Ocean and a Survival in Somalia", *International Journal of Nautical Archaeology* 9, 297–309.

[63] Adriaan H. J. Prins (1965) *Sailing from Lamu: A Study of Maritime Culture in Islamic East Africa, Assen, Holland* (Assem: Van Gorcum), 188.

innovation. The use of keelsons disappeared in Arabian Sea and Southeast Asian traditions.

Mtepe were built from planks hewn from green mangrove logs (Hornell 1941: 59). These planks made by splitting logs, not sawn planks, is one of the affinities with Southeast Asian and Maldivian traditions.

Mtepe carried a single square sail, made of matting, and set between a yard and boom. When sailing on the wind, the tack was hauled down to the bow much like the tack of a Southeast Asian *tanja* sails.

Photographs show the arrangement of the rigging (sheets, tacks, lifts, etc.) was similar to that used elsewhere. Hornell's claimed arrangement with the braces and lifts combined as a single line seems to be another misunderstanding.

Southeast Asia and the Maldives

Southeast Asia

Geographic Profile

For our purposes, the region extends from the Gulf of Martaban in Myanmar and includes all parts of the island and mainland Southeast Asia whence vessels have sailed to and on the Indian Ocean. The Indian Ocean coasts of Island Southeast Asia—Sumatra, Java and the Lesser Sunda Islands—rise steeply from an ocean trench to high volcanic ridges. There are few natural harbours and anchorages. No major maritime cultures have developed on those coasts. Shipping from island Southeast Asia and much of mainland Southeast Asia has reached the Indian Ocean through the Straits of Malacca and Sunda Strait.

Historical Profile

The Austronesian peoples of Island Southeast Asia were necessarily seafarers when they occupied the region, spreading south from Taiwan through the Philippines into Indonesia and the edge of the Indian Ocean World. The diffusion of Dong Son bronze drums, axes and other artefacts from northern Vietnam throughout Island Southeast Asia and as far as New Guinea shows that significant long-distance trade networks existed in the first millennium BCE.

I Wayan Ardika and Peter Bellwood show that trade relations between Southeast Asia and India date back to the second-century BCE.[64] Jan Wisseman Christie sees an "explosion of trading activity" in the sixth to the third centuries BCE in Southeast Asia in response to the development of wealthy classes in the societies of China and India ready to buy medicinal substances, spices and other luxury goods.[65] It was mariners from Southeast Asia who first opened up an all-sea route between China and West Asia.[66] There is indirect evidence of contact between Southeast Asia and East Africa at the same time. Blench looked at the introduction of plants, boat technology, disease and musical instruments from Southeast Asia to East Africa.[67] The introduction of sweet bananas, taro and elephantiasis occurred in the 1st millennium BCE. This is long before any systematic populating of Madagascar off the African coast by people of Southeast Asian origin. It is proposed that Madagascar was first significantly populated in the seventh- or eighth-century CE in the context of continuing contact between Southeast Asia and East Africa. On linguistic grounds, Alexander Adelaar[68] and others agree with Otto C. Dahl's[69] proposal that the immigrant population were people originally from southeastern Kalimantan, but the voyaging to Madagascar was a Malayu enterprise.

There is evidence that voyaging between Southeast Asia and Madagascar continued for a number of centuries. Ships sailing to Madagascar might have called at the southern Maldives but it was essentially an open ocean voyage using the southeast trade winds during the

[64] I Wayan Ardika and Peter Bellwood (1991) "Sembiran: The Beginnings of Indian Contact with Bali", *Antiquity* 65, 221–232.

[65] Jan Wisseman Christie (1995) "State Formation in Early Maritime Southeast Asia: A Consideration of the Theories and the Data", *Bijdragen tot de taal- land- en volkenkunde* 151.2, 242.

[66] Jan Wisseman Christie (1995) "State Formation", 250.

[67] Roger Blench (1996) "The Ethnographic Evidence for Long-distance Contacts between Oceania and East Africa", in Julian E. Reade (ed.), *The Indian Ocean in Antiquity* (London: Kegan Paul), 417–438.

[68] Alexander K. Adelaar (2006) "The Indonesian Migration to Madagascar: Making Sense of the Multidisciplinary Evidence", in Truman Simanjuntak, Ingrid H. E. Pojoh, and Mohammad Hisyam (eds.), *Austronesian Diaspora and the Ethnogenesis of People in Indonesian Archipelago* (Jakarta: LIPI Press).

[69] Otto Christian Dahl (1951) *Malgache et Maanyan. Une comparaison linguistique*. Avhandlinger utgitt av Instituttet 3 (Oslo: Egede Instituttet).

southern hemisphere winter months. The return voyage could have been made on the same route using the northwest monsoon during the southern hemisphere summer, or by sailing north of the equator where the southeast trades turn southwesterly during the southern winter. This route would take the ships to the northern Maldives and close to Sri Lanka. Whatever the route, this was the first regular trans-oceanic voyaging.

Extant Chinese texts first refer to the large trading ships from Southeast Asia, the *kunlun bo*, trading to China in the third-century CE. Pierre-Yves Manguin[70] provides a translation of this text and an eighth-century text based on earlier translations by Paul Pelliot (1878–1945) and Joseph Needham (1900–1995).[71] The ships are said to have been more than 50 m in length, carrying as many as four sails and to have sailed swiftly in heavy conditions.

Geoffrey Wade writes "[…] from the middle of the eighth century onwards the Chinese sources show the replacement of Kun Lun (Southeast Asian) traders arriving in China by Arabs and Persians".[72] However, three large tenth-century Southeast Asian ships wrecked in the western Java Sea, in fairly deep water, the Intan, Karawang and NanHan/Cirebon wrecks (see below) show that Southeast Asian vessels continued to trade to China and to load large cargoes there. There is also a wreck of a fairly large lashed-lug ship (keel more than 22 m length) dated to the ninth century on the basis of associated ceramics, in central Vietnam.[73]

When Portuguese shipping first reached Southeast Asia in 1512 they found cargo vessels called *jong*, which were much larger than their largest ship. Gaspar Correia (c. 1496–1563) described how Admiral Albuquerque's fleet attacked a *jong* (transcribed *junco* by the

[70] Pierre-Yves Manguin (1980) "The Southeast Asian Ship: An Historical Approach", *Journal of Southeast Asian Studies* 11.2, 175.

[71] Paul Pelliot [1878–1945] (1925) *Quelques textes chinois concernant l'Indochine hindouisée*, in *Études asiatiques, publiées à l'occasion du 25e anniversaire de l' École française d'Extrême-Orient*, vol. 2 (Hanoi: Impr. d'Extrême-Orient), 243–263; Joseph Needham (1971) *Science and Civilization in China*, Volume 4: *Physics and Physical Technology*, Part 3, *Civil Engineering and Nautic* (Cambridge: Cambridge University Press), 450, 453.

[72] Geoff Wade (2013) "Maritime Routes Between Indochina and Nusantara to the Eighteenth Century", *Archipel* 85, 86.

[73] Personal communication with Jun Kimura, April 2013.

Portuguese) from Pasai, Sumatera. For two days and nights, they ineffectually fired on the *jong*. The multiple layers of planking were too thick for the Portuguese' largest cannon to penetrate and the high poop of the Portuguese flagship was barely as high as the waist (the lowest point) of the *jong* making boarding impossible. The Portuguese persisted and eventually disabled the *jong*'s steering gear forcing the Sumaterans to surrender.[74]

At least one *jong* was sailed to Portugal, presumably re-rigged with a western rig that Portuguese mariners were familiar with. Nuno Rubim provided detail of a letter by King D. João III (1502–1557; r. 1521–1557) to the Conde da Castanheira, dated 22 August 1536. The King gives instructions about the "Armadas que devem andar em guarda da costa" (Coast Guard Fleets) which were deployed annually. The King wrote: "Pareceo me bem mandardes a Sacavem pelo galleam Trimdade e pelo junco" (It seems to me that you did right in ordering the deployment of the Galleon Trimdade and the *jong*, which were at Sacavem).[75]

The term *jong* was probably used for a range of large cargo vessels, some of purely Southeast Asian design and others belonging to a hybrid Southeast Asian and Chinese tradition that is discussed below.

The large *jong* which Afonso de Albuquerque's (1453–1515) fleet attacked in 1512 was said to have four layers of planking. This implies the use of nails to fasten the outer sheathing layers to the main (innermost) planking. A description of Javanese *jong*s written by Father Nicolau Perreira, S. J. in 1582, and translated in Manguin says of the *jong*s "They are not nailed together [with iron], but are [built] with wooden dowels […]" and reiterates "*There is nothing made of iron* aboard these *juncos*".[76] [Manguin's italics]. This suggests a more purely Southeast Asian type of *jong* in Java in the 1580s.

Large and strongly built though the Southeast Asian *jong* were, their trade was disrupted by the Portuguese and during the course of the sixteenth century the large *jong* disappeared, replaced by smaller cargo vessels that fed cargoes into the expanding international trade of the

[74] Gaspar Correa (1858) *Lendas da India*, vol. 1 (Lisbon: Academia Real das Sciencias), 216–218.

[75] Personal communication with Nuno Rubim, 2001.

[76] Pierre-Yves Manguin (1980) "Southeast Asian Ship", 267–268.

region. Detail and evidence is provided in Manguin's appropriately titled "The Vanishing Jong".[77] In "Lancaran, Ghurab and Ghali" Manguin discusses how Southeast Asian maritime polities, especially Aceh, put enormous effort and resources into developing martial fleets of colossal galleys with technical assistance from the Ottoman Empire during the second half of the sixteenth century and the early seventeenth century. An Acehnese galley captured by the Portuguese in 1629 and sailed to Goa was said to have been 100 metres long and "bigger than anything ever built in the Christian world".[78] The Acehnese galleys and others carried some heavy guns and enormous numbers of soldiers but galleys could not counter the broadsides fired by large European ships.

Although Southeast Asian shipping continued to carry cargoes within the region, voyaging on the Indian Ocean was probably reduced to contact with the Maldives (see Maldives section) and the annual voyaging from South Sulawesi to the north and northwest coasts of Australia to collect and process trepang (sea slugs) for export to China.[79]

Archaeology

Southeast Asian shipping is better represented by discoveries of shipwrecks than other regions of the Indian Ocean World.

The earliest wreck of a planked vessel discovered in the region is the third- to fifth-century CE Pontian boat. The timber remains were ^{14}C dated and provided a date consistent with associated ceramics.[80] In the Pontian boat, the Southeast Asian lashed-lug construction system was already fully developed. It is the system which remained central to Southeast Asian shipbuilding for most of the following thousand years and in some areas persisted till the twentieth century.

[77] Pierre-Yves Manguin (1993) "The Vanishing Jong", in Anthony Reid (ed.), *Southeast Asia in the Early Modern Era: Trade, Power, and Belief* (New York: Cornell University Press), 197–213.

[78] Pierre-Yves Manguin (2012) "Lancaran, Ghurab and Ghali: Mediterranean Impact on War Vessels in Early Modern Southeast Asia", in Geoff Wade and Li Tana (eds.), *Anthony Reid and the Study of the Southeast Asian Past* (Singapore: ISEAS), 166, quoting various Portuguese texts.

[79] Charles C. Macknight (1976) *The Voyage to Marege* (Carlton: Melbourne University Press).

[80] Ivor H. N. Evans [1886–1957] (1927) "Notes on the Remains of an Old Boat from Pontian, Pahang", *Journal Federated Malay States Museum* 12, 93–96; Carl A. Gibson-Hill (1952) "Further Notes on the Old Boat Found at Pontian, Southern Pahang", *Journal (Malay Branch) of the Royal Asiatic Society* 25:1, 111–133.

In the lashed-lug construction system, planks are hewn from logs in matching opposed (mirror image) pairs. Initially, logs are cleft in two. The inside of the log becomes the outside of the plank. The split log pairs are cut away to form planks using sharp tools—axe, adze and chisel, not saws. In this process lugs or nodes are left projecting on the inside face of the plank at regular intervals. Later in construction the frames will be lashed to these lugs with the lashings passing through holes bored in the lugs (but not bored right through the plank).

The plank-shell, made up of matching opposed pairs of planks, is assembled using edge dowels (also called tenon dowels) between the planks. These dowels are not visible once a plank is fitted.

The dowels can be locked by smaller dowels at right angles, but this is not always done, and even without locking dowels it is not usually possible to pull planks apart without snapping the dowels.

The Pontian boat has some stitches holding the planks together in addition to the dowels. It is presumed that stitching was more important at an earlier stage in the development of this system of construction when the dowels would have been fewer in number and perhaps smaller in diameter.

It has been proposed that the frames which are lashed to the lugs were flexible, and that having secured the ends of the fames to either side of the hull, the shipbuilders then forced the frames down to the shape of the hull thus stretching the frames and pulling the planks tightly together.[81] This assumes that the frames were not only flexible but somewhat elastic. There seems to be little evidence for flexible frames, if any, and many of the ships built in this tradition were far too big for flexible frames to have been possible.

Continuing a brief chronological survey of the archaeology, salvage archaeology rescued the remains of two dozen badly damaged planks and a small piece of a keel from a site (a pond) called Kolam Pinisi in a suburb of Palembang, Sumatera. “They clearly belonged to a large, sturdy hull that has its planks stitched together and fastened to the frames by way of lashed lugs”, and were ^{14}C-dated fifth to seventh century.[82] The plank remains and rudder found at Sambirejo, about 10 km

[81] G. Adrian Horridge (1978) *The Design of Planked Boats of the Moluccas* [Maritime Monographs and Reports, 38] (London: National Maritime Museum).

[82] Pierre-Yves Manguin (1996) “Southeast Asian Shipping in the Indian Ocean during the First Millennium AD”, in Himanshu P. Ray and Jean-François Salles (eds.),

downstream from Palembang, date to seventh to eighth century and appear to be from somewhat smaller vessels. The 5.94 m long rudder implies a vessel about 20 m long if the relationship between rudder size and hull size was similar to that in more recent times.[83]

Three large tenth-century ships with lashed-lug construction have been discovered in deep water in the Java Sea. They were excavated by salvors rather than pure maritime archaeological projects. These are the Intan wreck, found off South Sumatera in 1997, with a mixed cargo of Chinese ceramics and other artefacts, many of them made from metals and some of West Asian origin suggesting entrepot trade from Palembang, Śrīvijaya. The ship was about 30 m long.[84] The Krawang wreck is the least investigated, it has been only partly salvaged. Approximately 100,000 ceramic pieces were recovered. It is said to be have been approximately similar in size to Cirebon and Intan.[85]

The NanHan/Cirebon wreck was excavated/salvaged in 2004–2005 in 54 m of water, north of Cirebon. All the following data were provided by Horst Liebner. The wreck is on the rhumb line course from Palembang to Semarang (Central Java) but this is not known to be significant. The cargo was a range of artefacts similar to Intan but with a much greater number of ceramics. Approximately 500,000 ceramics, iron ingots and also artefacts from India and West Asia were recovered. The cargo was calculated to be "200–300 metric tons" by ascribing a conservative average weight to ceramic pieces. The ceramics were mostly Yue ware from NanHan 南漢 (917–971, Guangzhou and surrounding area).

The keel is 26.6 m long on the site drawing. The girth of the hull implied by the remaining planking is considerable. Furthermore, no indication of any beam ends or other structure which would indicate the sheer strake (top row of planks) were discovered, so there were

Tradition and Archaeology: Early Maritime Contacts in the Indian Ocean: Proceedings of the International Seminar on Techno-archaeological Perspectives of Seafaring in the Indian Ocean, Fourth century B.C.–Fifteenth century A.D., New Delhi, February 28 Markch 4 (New Delhi: Manohar Publishers and Distributors), 185.

[83]Cf., for example, Nick Burningham and Jeffrey Mellefont (1997) "The Exceptional Janggolan", *The Bulletin of the Australian Institute for Maritime Archaeology* 21:1–2, 42.

[84]Michael Flecker (2002) *The Archaeological Excavation of the Tenth Century Intan Shipwreck* [BAR International Series, 1047] (Oxford: Archaeopress), 125.

[85]Personal communication with Horst Liebner, 2013.

presumably more strakes than the remaining 14 strakes. The half beam of the 14 strakes is ~6 m. The full girth is not likely to have been less than about 15 m. Beam will have been about 0.7 girth unless the mid-section had a hard turn to the bilge and near vertical topsides, which is very unlikely. Thus a vessel of a little less than 30 m length, 10.5 m beam and perhaps 4 m depth in the hold is inferred.

The lower strakes have a continuous ridge rather than separate lugs. Those ridges are almost as wide as the strakes, thus the strakes are very thick with rabbets on their edges. There are many dowels edge-fastening the planking, some fitted in the "Maldivian" manner—right through planks and down into the one below. Some dowels have locking pins. There was a substantial keelson.

The Punjulharjo wreck found in a waterlogged terrestrial site near Semarang is more intact and approximately contemporary, though smaller and probably of a less capacious design. The lashed-lug construction is complex. The bow (? or stern) wing stem implies an angular profile with moderate rake, like the ships in the Borobudur iconography. Data was supplied by Pierre-Yves Manguin.

Planks and fragments of a number of vessels found at Paya Pasir, near Medan, North Sumatera are associated with twelfth–thirteenth-century Chinese ceramics and a twelfth–fourteenth-century harbour known as Kota Cina (i.e. "Chinatown"). The larger plank remains suggest the continuing use of lashed-lug vessels in approximately the size-range indicated by the three tenth-century Java Sea Wrecks.

Another Java Sea Wreck, found in open water near the western limits of the Java Sea and known as The Java Sea Wreck, is dated "mid- to late thirteenth-century based on the stylistic analysis of the ceramic cargo" and carbon dating of aromatic resin in the cargo.[86] Little remained of the hull structure, however, analysis of hull timber showed it to be a tropical hardwood, possibly *Parastemon urophyllum* and the presence of large dowels or treenails indicate Southeast Asian construction.[87] The cargo was principally iron bars and iron artefacts such as Chinese cauldrons, amounting to about 190 tons. There were also large quantities of Chinese and Thai ceramics, and smaller quantities of ivory and resins thought to be from

[86] This and data below are from Michael Flecker (2003) "The Thirteenth-Century Java Sea Wreck: A Chinese Cargo in an Indonesian Ship", *The Mariner's Mirror* 89.4, 388–404.

[87] Michael Flecker (2003) "Thirteenth-Century Java Sea Wreck", 392.

Sumatera. Flecker speculates on the basis of the distribution and division of the cargo that the ship had 12 bulkheads and points to a Javanese text which "mentions the King of Sunda [West Java] sailing to Majapahit [East Java] in 'a jong of Chinese build such as came into use after Wijaya's war'".[88] However, Flecker also acknowledges that the transverse divisions of the cargo could indicate tiers of beams crossing the hull, which is consistent with lashed-lug construction.

It was at a 1983 workshop (published 1984) that Pierre-Yves Manguin drew attention to the accumulating evidence for a hybrid "South China Sea tradition" of shipbuilding, which combined elements of Southeast Asian technique and design with Chinese elements in the late-medieval and early-modern periods. Shipwreck archaeology in the Gulf of Thailand, published principally by Jeremy Green, was contributing much of the evidence that ships of this hybrid tradition were widely used and significant. Further discoveries and investigations of shipwrecks in the intervening thirty years have reinforced that conclusion. Michael Flecker provides a clear and concise review of the archaeology and summarizes the characteristics of ships belonging to this hybrid tradition.[89] The following list is adapted from Flecker[90]:

1. There is a substantial keel with upper edges bevelled to take the first row of planks.
2. The inner layer of hull planking is a plank-shell edge-dowelled together.
3. Multiple layers of planking. The inner layer is the main structural planking, the one or two outer layers are sheathing.
4. The sheathing layers are nailed to the inner plank-shell.
5. There are structural bulkheads (about 12 to 18) approximately regularly spaced throughout the length of the hull.
6. The bulkheads are often made up of planks edge-dowelled together.

[88] Michael Flecker (2003) "Thirteenth-Century Java Sea Wreck", 393, citing Pierre-Yves Manguin (1984) "Relationships and Cross-Influence Between Southeast Asian and Chinese Shipbuilding Traditions", in SEAMEO Project in Archaeology and Fine Arts (ed.), *Final Report Consultative Workshop on Research on Maritime Shipping and Trade Networks in Southeast Asia* (Bangkok: SPAFA Coordinating Unit), 201.

[89] Michael Flecker (2007) "The South-China-Sea Tradition: The Hybrid Hulls of South-East Asia", *International Journal of Nautical Archaeology* 36.1, 75–90.

[90] Michael Flecker (2007) "The South-China-Sea Tradition", 81.

7. In some cases, there are wooden "stiffeners" which fasten the bulkheads to the plank-shell.
8. There are frames fitted on one side of each bulkhead. Occasionally there are frames on both sides of a bulkhead. Where there is a frame on only one side it is often the side closer to midships or to the mainmast step which is close to midships. However, in some cases where the bulkheads are fastened to the plank-shell by timber stiffeners, it is the stiffeners that are on the midships facing side of the bulkheads and the frames are on the sides towards the bow or stern.
9. The inner planking is fastened to the frames with large, square-section iron nails.
10. The planks that make up the strakes of the main planking are joined with long, stopped scarfs that usually lie under frames/bulkheads.
11. The planks of the outer sheathing layers are butt-joined
12. Some examples have transverse-fitted mast steps which have mortices to take the cheeks of mast tabernacles, but there are also examples of mast steps with a single mortice to take the heel of the mast.
13. Where mast steps have been found there is usually a mainmast step near midships and a foremast step well-forward.
14. The hull midsection shape has hollow deadrise ("wineglass shape").

Characteristics 1, 2, 10, and 14 can be seen as essentially Southeast Asian, albeit 14 had been adopted by some Chinese shipbuilders.

Characteristics 4, 5, 7, and 9 can be seen as essentially Chinese.

Multiple layers of planking are probably also Chinese in origin. Nails are required to fasten the sheathing layers to the main planking.

Other characteristics of the hull construction are results of the hybridization.

The mast positions and use of tabernacles are typical for both traditions although early Southeast ships, as depicted at Borobudur, often had bipod masts with the mainmast forward and a second mast aft.

The essence of the construction, that the hull was primarily a plank-shell held together by edge-dowelling is Southeast Asian and indicates that the shipbuilding was mostly done by Southeast Asian shipwrights.

All the seventeen examples that Flecker discusses were found with ceramic cargoes. Most of them were largely fifteenth- or sixteenth-century ceramics from Thai kiln-sites, principally Sawankhalok, Sukhothai and Singburi. The export trade of the Thai ceramics industry expanded spectacularly in the late fourteenth century filling the void created by the Ming edict issued in 1371 banning private overseas trade. It is thought that Chinese merchants residing in Southeast Asia were important in the development of this trade[91] and the commissioning of the associated shipping.

The fact that all the shipwrecks have been found with ceramic cargoes cannot be taken as indicating that these ships carried almost nothing but ceramics. As Flecker points out, most of the shipwrecks have been discovered accidentally by fishermen, well offshore and in fairly deep water. It is the ceramics caught in nets that indicate the shipwreck sites which then come to the notice of authorities either because they are reported or because of looting operations.[92]

The hybrid South China Sea Tradition disappears from the archaeological record in the early seventeenth century, whether this reflects the complete disappearance of the type or the drastic reduction in ceramic cargoes is not certain. Some evidence for the persistence of the type is adduced from the iconography.

Iconography

The Borobudur ships: There were ten watercraft depicted among the many scenes in the very extensive galleries of bas-reliefs at the eighth-century Borobudur Temple in Central Java. One of those depictions is now lost. Five were relatively small craft while the other five were larger vessels carrying important personages. Those five larger vessels are all fairly similar in design, but not identical, and they are not all carved by the same artist—there are differences in the quality of artistry.[93] They appear well detailed and accurate within the limitations of bas-relief carving of somewhat coarse textured rock and the narrative

[91] John S. Guy (1990) *Oriental Trade Ceramics in Southeast Asia, Ninth to Sixteenth Century* (Singapore: Oxford University Press), 59.

[92] Michael Flecker (2007) "The South-China-Sea Tradition", 89.

[93] Theodoor van Erp [1874–1958] (1923) "Vorstelling van vaartuigen op de reliefs van den Boroboedoer", *Nederlandsch-Indië Oud en Nieuw* 8, 239.

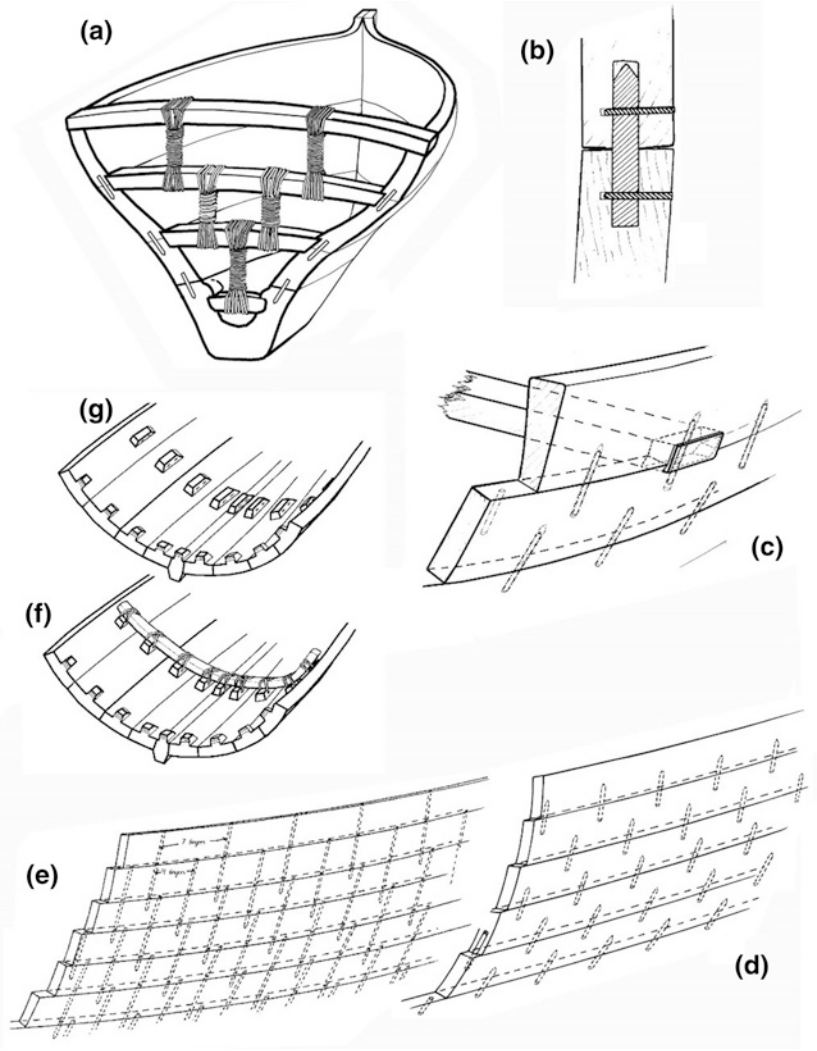

Fig. 6.7 Lashed-lug and edge-dowelled construction: (a) section of simple hull showing beams arranged in tiers and lashed together; (b) edge dowel with locking pins; (c) edge-dowelled planking; (d) typical Southeast Asian pattern of dowelling; (e) Maldivian pattern of dowelling with dowels penetrating three planks; (g) section of a simple hull showing lashed-lug construction, the frame timbers ("ribs") are lashed to the lugs

intent of the tableaux. Although they have been claimed as depictions of Chinese[94] and Indian vessels,[95] there should be little doubt that they are Indonesian vessels. The use of outriggers, the *tanja* sails, bipod masts, the arrangement of the quarter rudders, and fine details such as the fairings on the outriggers and the outrigger connectives, are all characteristically Indonesian. In discussing the several depictions of ships at Borobudur we will distinguish them using the text figure numbers ascribed by Theodoor van Erp (1874–1958).[96]

The Borobudur vessels carry double outriggers, but this is not easily discerned. In four of the five Borobudur ship depictions, only the windward side of the vessel is shown. Whether the vessels are double outriggers with another outrigger on the leeward side or single outriggers carrying a flying outrigger on the windward side only cannot be determined with certainty. However, Erp 10, which has its sail partly furled, has that sail on the side of the mast towards the viewer what suggests that we are looking at the leeward side. Four of the five depictions show the port side of the vessel but Erp 9 shows the starboard side so outriggers are seen on both sides, and both to windward and to leeward of the hull, though not simultaneously. Even if this were not the case, it is unlikely that the Borobudur ships could have been single outrigger craft.

Most single outrigger vessels are designed to tack by "shunting" in order that the outrigger remains on the windward side when they change tack. When a vessels tacks by shunting, it reverses direction and reverses ends—the bow becomes the stern and vice versa—the steering gear must be shifted from one end to the other and the rig reconfigured to drive in the opposite end. Such vessels are necessarily longitudinally symmetrical—the ends are very similar—and they have a simple rig, which can be reversed, usually with the mast positioned midships.

The Borobudur ships do not exhibit longitudinal symmetry and do not have rigs that could be reversed.

There was a type of a large single outrigger vessel from Sri Lanka, the *yatra dhoni,* which did not shunt. The hull form of the *yatra dhoni* had

[94] Joseph Needham (1971) *Civil Engineering and Nautics*, 457–458, Fig. 937.

[95] Cf., for example, Radhakumud Mookerji [1884–1964] (1912) *Indian Shipping: A History of Sea-Borne and Maritime Activity of the Indians from the Earliest Times* (Bombay *et al.*: Longmans, Green and Co.), frontispiece and plates 1–6 facing 46 and 48.

[96] Theodoor van Erp (1923) "reliefs van den Boroboedoer", 227–257.

enough beam and stability if ballasted to sail without an outrigger.[97] It seems possible that the outrigger could be shifted from one side to the other (with some difficulty) and that the *yatra dhoni* was used mainly for long monsoonal voyages to and from India when wind direction might be consistent for the entire duration of the voyage. The name *yatra dhoni* means "pilgrimage boat". Henry C. Folkard says of the "Dhoney or Yatrawe": "These dhoneys are fast sailing vessels, and are usually fitted with *shifting* outriggers […]" (italics added) implying that some did not carry an outrigger and that the outrigger could be shifted to be carried on either side of the hull depending on the prevailing monsoon and the direction of the intended voyage.[98]

Single outrigger canoes are used on some parts of the north coast of Central and West Java. They have a single outrigger boom and they shift the outrigger from one side to the other when changing tack. The arrangement is simple, loose, and temporary in appearance. It is not suitable for larger sea-going vessels. The Borobudur ships have three or four outrigger booms of complicated construction: It does not look like an arrangement that could be shifted when changing tack.

Large single outrigger, non-shunting, canoes were built at Macassar, South Sulawesi. These vessels were built exclusively for racing and were a single outrigger version of the double outrigger *jerangkat*. They had one very large outrigger and employed a lot of movable human ballast when racing.[99]

Double outrigger canoes are not widely used on the coasts of Java but they are more common on neighbouring islands including Madura and Bali where sophisticated designs exist.

The Borobudur outriggers have a number of characteristics that make them significantly different from the outriggers of sailing canoes of more recent times. The outriggers of Indonesian vessels, including those first depicted by Europeans in the late sixteenth century, have generally been similar in length to the hulls of the canoes they were fitted to. In many

[97] Tom Vosmer (1993) "The Yatra Dhoni of Sri Lanka", *Bulletin of the Australian Institute for Maritime Archaeology* 17.2, 37–42.

[98] Henry C. Folkard [1827–1914] (1870) *The Sailing Boat* (London: Longmans, Green & Co.), 315–316.

[99] George E. P. Collins (1936) *East Monsoon* (New York: Scribner).

Table 6.1 Outrigger lengths

Erp no.	*Outrigger length as decimal fraction of hull waterline length*
Erp 6	0.545
Erp 7	0.585
Erp 8	0.79
Erp 9	0.64
Erp 10	0.750

cases, they are longer than the hulls. The Borobudur ships all have outriggers shorter than the waterline length of their hulls. Erp 6 (which appears to be the largest vessel) has an outrigger only 0.54 the length of the hull. Erp 8 has the longest outrigger at 0.79 the length of the hull; it has four outrigger booms while the other vessels have three outrigger booms (Table 6.1).

On all but one of the Borobudur ships the outriggers are doubled—there are two outrigger components, which are presumably bamboos, one on the inboard side of the outrigger boom/connective, one on the outboard side.

Some of the Indonesian vessels recorded by Captain Pâris in the nineteenth century had outriggers of relative lengths that fell within the range illustrated in the Borobudur ships. They were mostly from the Moluccas and neighbouring regions of Eastern Indonesia where outriggers have remained relatively short in more recent times. Lightweight timber rather than bamboo is often used for outriggers in Eastern Indonesia (in some areas suitable bamboo is unavailable), and outrigger craft depends on movable human ballast for stability.[100]

By contrast, in areas closer to Java (e.g. Bali, Madura) outriggers are usually significantly longer than the canoe they are fixed to. Often, relatively large and fast sailing canoes have a crew of only one or two persons and depend on the buoyancy and hydrodynamic lift of the lee outrigger for stability.

On all the Borobudur ships there is an outrigger attached on the outboard side of the boom/connective. On all except Erp 8, there is

[100] François-Edmond Pâris [1806–1893] (1841) *Essai sur la construction naval des peuples extra-Européens* (Paris: Artus Bertrand); Eric Rieth (1992) *Le Voyage de la favorite: Collection de bâteaux dessinés d'après nature, 1830, 1831, 1832*, illustrated by François-Edmond Pâris [1806–1893] (Arcueil: Editions ANTHÈSE).

another outrigger on the inboard-underside of the boom. The booms or connectives (it is not clear which they are) project below the outriggers suggesting the outriggers were meant to fly clear of the water.

The Borobudur outriggers do not appear large in diameter. They are shown with diameter about the same as that of the outrigger booms or less than that of the booms. This relative proportion probably reflects the large size of the ships and the upper limit to the size of bamboo available.

All the features noted above suggest that the outriggers of the Borobudur ships were not intended to provide stability to the extent that the leeward outrigger of double outrigger canoe normally does: They lack volume and therefore the buoyancy to resist heeling. They are not faired to cut through the water. The outrigger booms or connectives project below the outriggers and would cause significant drag to the detriment of speed and steering if depressed into the water. Erp 9 shows its lee outrigger apparently flying clear of the water since the outrigger boom (connective) ends can be seen projecting below the outrigger.

If it is concluded that the outriggers are not primarily intended to provide stability another explanation of their use is required. Like the outriggers of the nineteenth-century bouanga from New Guinea, drawn by Pâris, the outriggers could be seats for paddlers to propel the vessel in calms and in martial use. They would also serve as a defensive barrier against hostile boarding parties. If the outriggers were not designed to be the vessel's primary source of stability then the hull form would not be a typical outrigger canoe hull form. Instead, it would have a broader, more stable, and more capacious hull form. Despite this relatively capacious hull form, the type of sea-going ship depicted at Borobudur cannot have been the type of ship used for carrying large cargoes. A "Borobudur ship replica" built in 2002/2003 (designed by the author) was given 19 m length which is about the upper limit for the design for various structural and materials engineering reasons.

The Borobudur ships cannot tell us much about the large and capacious cargo vessels of the eighth century. What we are shown are swift and easily defended vessels carrying important personages and probably devised for martial use (Fig. 6.8).

A bas-relief at Angkor Thom, Cambodia, depicts a two-masted sailing vessel. Whether the vessel depicted is a Chinese vessel or a Southeast Asian vessel has been an open question. Claims have been made for both.

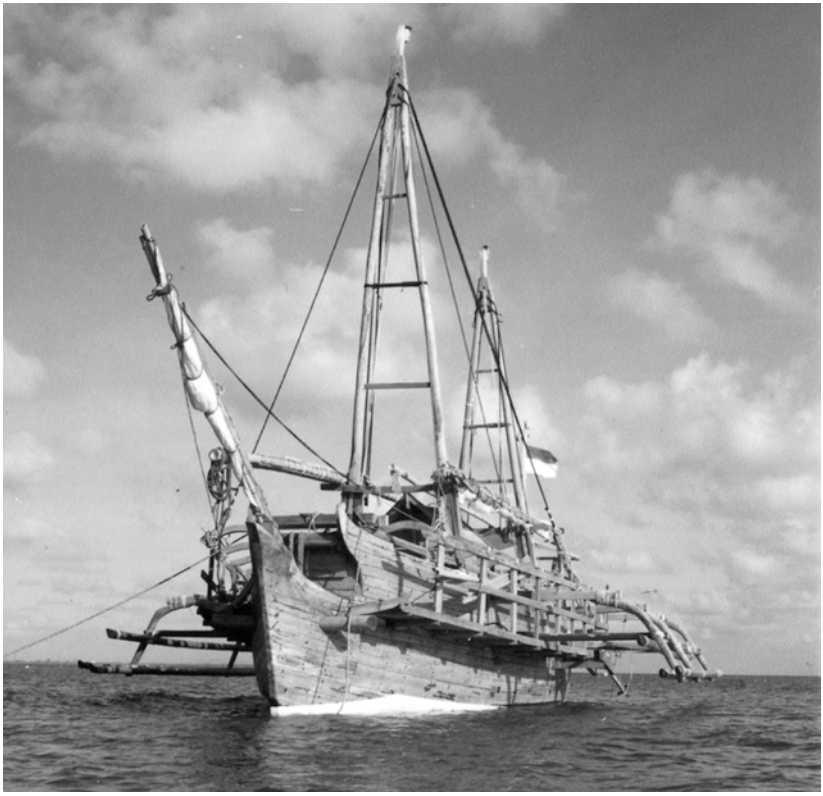

Fig. 6.8 Reconstruction of the type of sea-going ship depicted at the eighth-century Candi Borobudur. The reconstruction was successfully sailed across the Indian Ocean, around the Cape of Good Hope and to Ghana. The tall shields shown on bow and stern of the Borobudur ships are not fitted, because they obstructed view to an extent that contravened Regulations for the Prevention of Collision at Sea ("Colregs")

For example, Needham assumes it is Chinese,[101] while Manguin argues for it being Southeast Asian.[102] The most salient argument for it being a Southeast Asian vessel is the hull shape. It appears to be a sharp,

[101] Joseph Needham (1971) *Civil Engineering and Nautics*, Fig. 975.

[102] Pierre-Yves Manguin (1993) "The Vanishing Jong", 197–213.

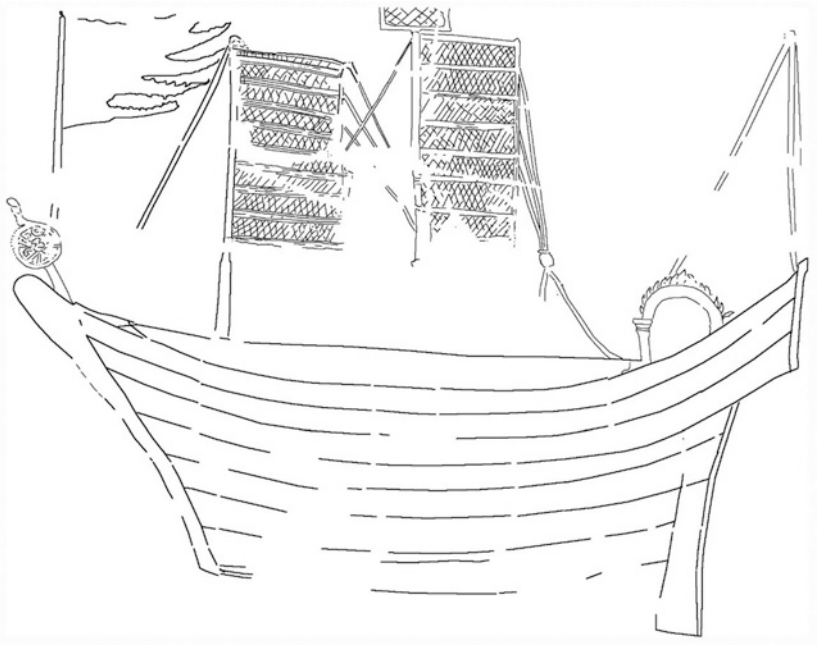

Fig. 6.9 Tracing of the ship depicted at Angkor Thom, Cambodia. Human figures are not shown

double-ended hull with a stem that has a concave profile and a prominent stemhead. The stern profile is also slightly concave. The style of the hull is certainly Southeast Asian and it is not difficult to find photographs and drawings of much more recent vessels with very similar appearance. It does not have a transom bow or stern, which would be expected if it were a Chinese vessel (Fig. 6.9).

All the medieval Chinese shipwreck archaeology, where enough of the ship structure remains for the bow structure to be known, shows transom bows.[103] There is a small medieval vessel at Ningbo, which has been reconstructed with a sharp modern bow, but this is speculative. There is very little medieval iconography that shows sea-going Chinese vessels. One Tang dynasty depiction of a large boat shows a transom bow. A famous Song dynasty scroll painting entitled *QingMing shanghe tu*

[103] Kimura Jun, ed. (2010) *Shipwreck ASIA. Thematic Studies in East Asian Maritime Archaeology* (Adelaide: Maritime Archaeology Program, Flinders University), 1–25.

清明上河圖 (Along the river during the Qingming Festival) by Zhang Zeduan 張擇端 (1085–1145) shows several large river barges. Most appear to have broad transom bows or scow bows in which the flat bottom curves up to form a transom-like bow. Some however have round sterns or nearly round sterns with small transoms. The Japanese scroll painting entitled *Mōko shūrai ekotoba* 蒙古襲来絵詞 (Illustrated account of the Mongol invasion), composed between 1275 and 1293, which illustrates the attempted Mongol invasion of 1281 shows transom bows and flat-bottomed construction with the flat bottoms curving up into the bow and stern.

The assumption that it is a Chinese vessel rests on the sails which are probably battened lug sails also termed "junk sails". This is the oldest known depiction of battened lug sails. The sails are rectangular, they appear to be made of smaller rectangular panels of some form of matting, arranged horizontally between battens that are likely to have been bamboo. The sheets (controlling ropes) are connected by multiple bridles to all the battens and to the spar at the head of the sail and the boom at the foot of the sail. In these respects, the sail is typical of the form of battened lug sail depicted in early-modern iconography. In one respect it is atypical—there is no part of the sail forward of the mast it is set from. It might be that a small part of the sail and spars overlaps the mast and is hidden behind the mast, but no part projects forward. It is not clear how the sail was set and the technical term lug sail might not be appropriate. Although this is atypical, there is a small subset in the early-modern iconography, which has this characteristic.

The Angkor ship appears to have a narrow-bladed rudder mounted on the stern and extending below the keel. Having a rudder which can project below the hull is arguably a Chinese characteristic. The earliest evidence for rudders fitted on the centre line of the hull (rather than the quarters) is from China (there are several Han dynasty pottery models of river boats which have median rudders). Chinese rudders were not hung from the sternpost because Chinese vessels had no sternpost. They were fitted to the stern transom using brackets which allowed them to be raised and lowered. When lowered below the hull the bottom of the rudder was braced forward by a pair of lines taken right to the bow, presumably so that hydrodynamic drag on the rudder did not cause it to jam in the brackets. When the rudder fitted on the centre line was adopted in Indo-China is unknown because there is no other iconography or any other evidence until the sixteenth century. Further south, in

Indonesia, quarter-mounted rudders persisted until recently. Circa 1600 Dutch iconography shows that median mounted rudders were also used there, but were not common. The artist's intentions in the depiction of the rudder (assuming that it is a rudder) are not entirely clear. It disappears into the hull planking two strakes below a stern gallery, but the detail is obscured by joints in the masonry which the image has been carved on. It could possibly be a quarter rudder mounted on beams inside the stern gallery.

There are only two known Chinese depictions of sea-going sailing ships, which are thought to predate the Ming ban on sea-going ships. The *Mōko shūrai ekotoba* does not show any masts or sails. A woodcut print entitled *Tianfei jing* 天妃經 is thought to date from about 1420. It shows a number of apparently large, flat-bottomed vessels, each setting tall rectangular sails on three masts. There is some hint of horizontal battens and it is clear that the sheets are bent to the sail by multiple bridles. One can count twelve or more per sail, suggesting sails with twelve or more battens and panels. The lead of these bridles or sheets is strange and probably wrongly depicted—they go nowhere that they could be usefully belayed. The sails were either set like square sails symmetrically on the mast with an equal area either side, or very nearly symmetrically with almost as much sail forward of the mast as there was aft of the mast.

The other depiction, underglaze painted on a dish (in the collection of the Hong Kong Maritime Museum) shows a high-sided vessel. The hull is shown in profile so the structure of the bow and stern cannot be discerned. There is one sail each on a foremast stepped right in the bow and on the mainmast stepped very slightly closer to the bow than the stern. The mainsail is clearly shown to be set square. Because it is symmetrically set on its mast it necessarily has controlling ropes (sheets or braces) bent to both ends of the battens. There are multiple bridles attaching these controlling lines to the battens which are numerous. The arrangement of the foresail is less clear. It might be a lug sail rather than square sail.

Because the sails shown in the *Tianfei jing* are more or less symmetrically set, they would need a similar arrangement with controlling lines to both edges of the sails which means they would have functioned as battened squaresails rather than battened lugsails.

The Angkor Thom bas-relief is the earliest known representation of battened lug sails. It is located in Southeast Asia and probably shows a Southeast Asian vessel.

The Homem-Reineis Atlas, also known as the "Atlas Miller", of 1519 is decorated with miniature scenes and depictions of ships by António de Holanda (1480–1557). The European ships are easily distinguished and to avoid any possible confusion they have large Maltese crosses on their sails. The Arabian ships, of which there are two distinct types, are also easily distinguished and have crescent moons on their sails. There is a third type of ship shown on the Eastern side of the Indian Ocean and the South China Sea with crescents on the sails of three of the four examples. This type is clearly meant to be large: There are examples with four, five, six and seven masts. Single, deep, square sails are carried on each mast. There are quarter rudders on the stern. The hulls are double-ended with stem and sternpost. The stemheads are tall with a large fiddlehead that recurves inboard. It seems very likely that these miniatures are intended to represent the large ships of Southeast Asia, the jonques. Since we have no other depictions or descriptions of the large Southeast Asian ships that the Portuguese encountered in the early sixteenth century, we cannot be certain how accurate or fanciful these depictions are. Square sails are not carried by any Southeast Asian vessels, unless Irrawaddy river boats are included, and sails without a boom on the foot are very unusual in Southeast Asia. The large number of masts is not attested elsewhere. The five-masted vessel is depicted with its port bow towards the viewer. It appears to have tumblehome (the upper hull sides curve inwards), which is not a characteristic found in Southeast Asian vessels. Probably António de Holanda has filled in a lot of missing detail in these depictions. Assuming that they are not entirely invented, it is fairly certain that these are not Javanese vessels because a consistent stylistic feature of Javanese vessels is that the stern profile is more raked than the bow profile. These vessels have strongly raked and curved bows while their sterns are less curved and only slightly raked. Perhaps the ships of Aceh or Pegu are intended?

As discussed above, by the time Dutch shipping reached Southeast Asian waters the large cargo-carrying *jong* had more or less disappeared. Dutch iconography, starting with Willem G. M. A. Lodewijcksz (sixteenth century) shows relatively modestly sized *jong*. In depictions of Dutch and local shipping at Bantam (Banteng, West Java) the larger *jong* are bigger than the Dutch jacht *Duyfken* (about 60 tons cargo capacity) but not as big as the ships.[104] What we see are graceful, double-ended

[104]Willem G. M. A. Lodewijcksz [*fl.* sixteenth century] (1598) *D'eerste boeck. Historie van Indien, waer inne verhaelt is de avonteuren die de Hollandtsche schepen bejeghent zijn* (Amstelredam: Cornelis Claesz), plate 11.

vessels with a high stern, and with rudders mounted on both quarters. There are deck beams protruding from the side of the hull. The sails are "tilted quadrilateral sails" for which we have no technical name in English and called *layar tanja* in Indonesian. Although the sail type is quite different from the battened lugsail "junk rig", the mast placement and the forward rake of the foremast are similar.

As discussed above, the textual evidence that some *jong* were built entirely without iron fastenings, and some had multiple layers of plank sheathing, which would need to be nailed on, suggests that a range of designs could be designated *jong* (Fig. 6.10).

Godinho de Erédia drew a different type of *jong* circa 1613.[105] The profile of the bow is similar, there are protruding deck beams, and there are quarter-mounted rudders, but the tall stern is square, it is some form of transom stern. The masts are similarly positioned, and there is a third (mizzen) mast in the stern, but the sails, which are lowered, appear to be battened lug sails. We cannot tell how the sails were set. They could be set like the sails of Chinese junks, with all the battens held to the mast by lines called parrels, or they could be set in the Southeast Asian fashion, more like European dipping lug sails. The square stern and the battened lug sails suggest that Erédia has drawn a vessel which was a hybrid South China Sea ship. It is similar to a vessel called a *soma* and said to come from Amoy (Xiamen) by Willem G. M. A. Lodewijcksz (1598) a vessel said to be Japanese by Jodocus Hondius (1563–1612; 1606) and a Javanese vessel illustrated in Isaac Commelin (1598–1676).[106] This seems to be a problem of ships being denominated according to where they trade to, rather than where they were built, like East Indiamen and China Clippers built in Britain. There is evidence that the Japanese were buying cargo vessels from Thailand in the late sixteenth century.[107]

An early eighteenth-century Japanese scroll painting, *Tōsen no zu* 唐船の図 (Map of Chinese junks), illustrates several types of junks that traded to Japan. Most of them are very similar in appearance, but the Ningbo junk and the junk from Siam are clearly different.

[105] Reproduced in Pierre-Yves Manguin (1980) "The Southeast Asian Ship", 266–276, Fig. 2.

[106] Isaac Commelin [1598–1676] (1646) *Begin ende Voortgang van de Vereenigde Neederlandtsche Geoctroyeerde Oost-Indische Compagnie* (Amsterdam: Johannes Janssonius).

[107] Yōko Nagazumi 永積洋子 (2001) *Shuinsen* 朱印船 (Tōkyō: Yoshikawa kobunkan), 60–62.

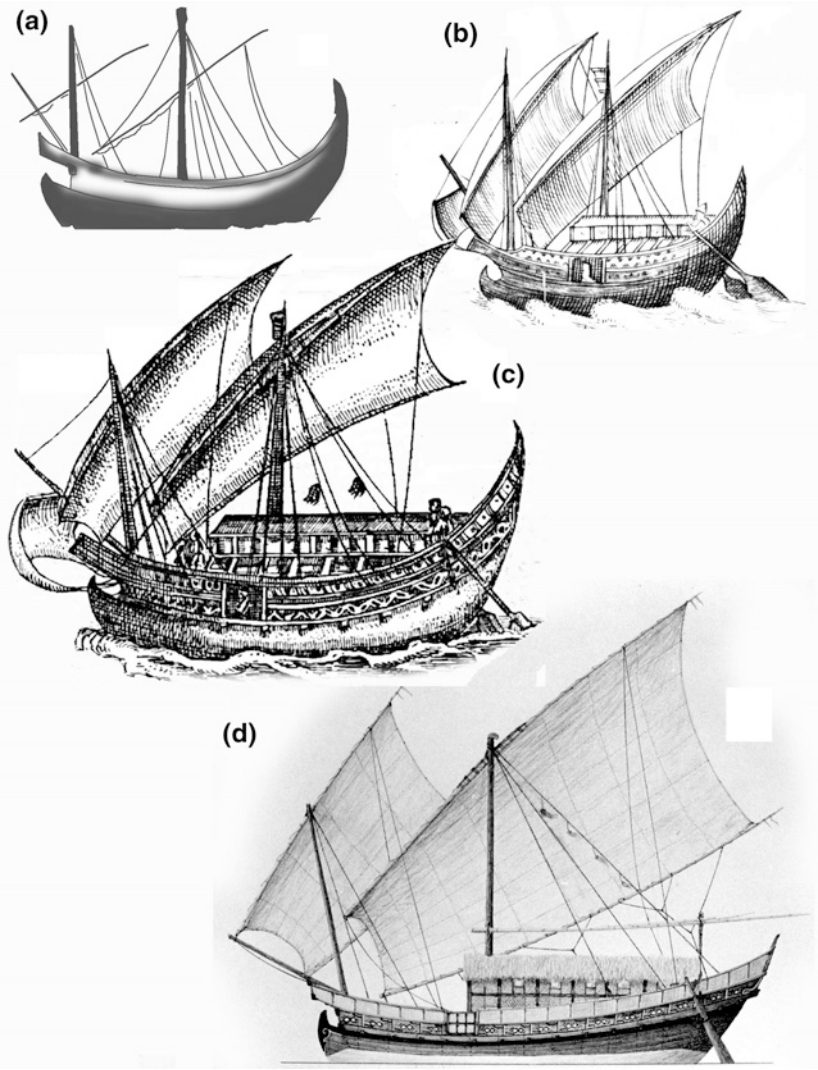

Fig. 6.10 Late sixteenth-century Javanese *jong*: (a) traced from a depiction of Banten Bay; (b) traced from a map known as the "Langren fragment"; (c) by Lodewijcksz, probably the earliest such depiction; (d) reconstruction of the design

The keel of the Siam junk has more rocker (upwards curve towards the ends) than those of the other vessels, particularly in the stern, and the transom stern is relatively small and narrow. Given the rocker and the relatively fine stern, the midships cross section of the hull is likely to have had significantly more deadrise than the midsections of the Chinese vessels. This Siamese junk may be seen as an eighteenth-century continuation of the hybrid South China Sea shipbuilding tradition. The junk-rigged, sharp-bowed tongkangs of Malaysia and Thailand, which traded until the early 1980s were arguably the last of the tradition.

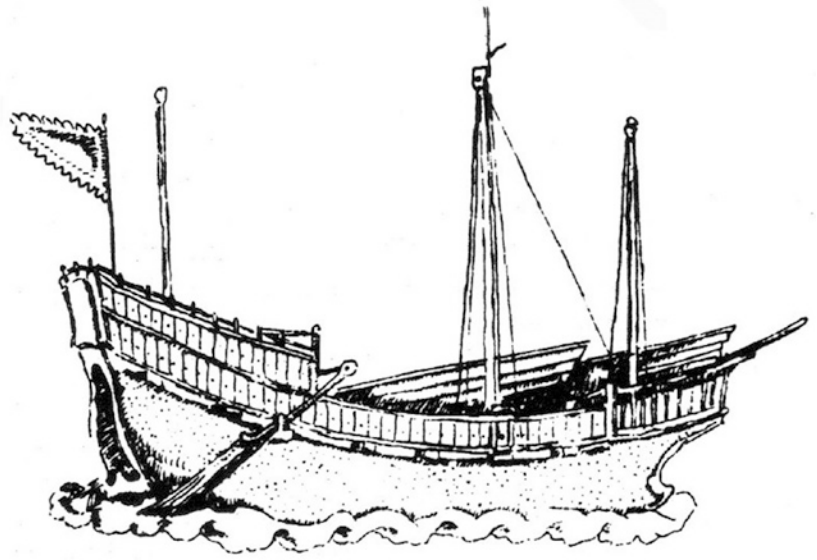

Fig. 6.11 Tracing of Heredia's depiction of a *jong*. This is a type of vessel different from the Javanese jong though the construction was probably similar. It is a hybrid design with the square stern of a Chinese ship, but the quarter rudders and sharp bow of Southeast Asian design. The sails, which are shown lowered, could be either battened lugs sails like those of Chinese junks, or stiff matting lug sails of Southeast Asian design

The Maldives

Geographic Profile

The Maldives is an archipelago of approximate 1200 small islands and islets with an average elevation above sea-level of about 1.5 m and no natural elevation greater than 2.3 m. The people of the Maldives are necessarily maritime oriented and the first inhabitants arrived by sea from the Indian mainland some 500 nautical miles to the east. The first inhabitants are thought to have come from Kerala in the Sangam period (300 BCE–300 CE).[108]

Historical Profile

The Maldives are mentioned in numerous medieval texts. Ibn Baṭṭūṭa (1304–1368 or 1377) supposedly spent several months at Male in the Maldives. In the twelfth century, the Maldives converted from Buddhism to Islam but remained an independent polity until the Portuguese briefly imposed control in the sixteenth century. The extent to which Maldivian shipping engaged in long-distance trade is not known, however early in the sixteenth century Barbosa reported on the ships of the Maldives: "they have keels and are of great burden".[109] That they had ships of "great burden" (great cargo capacity) implies that they were engaged in more than inter-island trade. The Maldivians continued to build substantial cargo vessels for trade to India and Sri Lanka into the twentieth century. The fleet was laid-up during World War II and never sailed again.

(When Barbosa describes a vessel as having a keel, he means not only that the hull is built from a central longitudinal baulk of timber, he also means that the vessel has a sharp bottom—a V-shaped cross section, or a wineglass-shaped cross section below the waterline—in technical terminology the hull has significant deadrise.)

The Maldives are regarded as a distinct region in discussion of Indian Ocean Shipping because the technique of shipbuilding traditionally employed in the Maldives is different from that found in India, Sri Lanka

[108] Xavier Romero-Frias (1999) *The Maldive Islanders: A Study of the Popular Culture of an Ancient Ocean Kingdom* (Barcelona: Nova Ethnographia Indica); Clarence Maloney (1995) "Where Did the Maldives People Come From?", *International Institute for Asian Studies Newsletter* 5, http://www.iias.nl/iiasn/iiasn5/insouasi/maloney.html (accessed 24 July 2013).

[109] Chandra R. de Silva (2009) *Portuguese Encounters with Sri Lanka and the Maldives* (Norfolk: Old Dominion University).

and the Arabian Sea region. It has strong similarities to the traditions of Southeast Asia and is seen as having been derived from that region.[110] In design, in basic structure and methods of assembly, and in styling, Maldivian vessels of recent times showed considerable to similarity to designs found in Southeast Asia. Specifically, the Maldivian *dhoni* is similar in hull form to the *kelulis-belang* type of central and southern Maluku (the Moluccas), but is more similar to certain types of *mayang* from West Java in its styling.

The planked boats of the Maldives are plank-first constructed: The planks which form the hull are edge-dowelled together, then the frame timbers and beams are fitted into that shell. The same process of shell-first construction is standard in Southeast Asia. However, the details are not always identical. In recent Maldivian practice (observed at Male and Alifushi) the dowels penetrate through two and a half planks and are spaced at seven finger widths (approximately 120 mm) and the dowels in the next strake are offset by three finger widths—this shift ensures that dowel holes drilled through two and a half planks do not penetrate previously fitted dowels (Fig. 6.7e). In Southeast Asian practice dowels only penetrate part way into two adjacent planks (Fig. 6.7d). Planks used in Southeast Asia are generally considerably wider than the coconut-wood planks traditionally used in the Maldives. In general, in the western part of the Indo-Malay region, dowels are small in diameter (10–12 mm), short, and closely spaced (75–100 mm), while in the eastern part of the region, dowels are longer, usually 18–20 mm diameter, and spaced at one hand span (200 mm). A derelict boat inspected at Alafushi in the Maldives was observed to have dowels penetrating only part way into two adjacent planks as would be the case in a Southeast Asian vessel.[111] The use of long dowels passing through two and a half planks is believed to be a recent development inspired by the use of electric drills, which facilitate the drilling of deep holes.[112]

Some dowels on the tenth-century Cirebon shipwreck penetrate right through planks in a similar way.[113]

[110] Pierre-Yves Manguin (2000) "Les techniques de construction navale aux Maldives originaires d'Asia du Sud-Est", *Techniques & Culture* 36, 21–47.

[111] Karen Millar (1993) "Preliminary Report on Observations Made into Techniques and Traditions of Maldivian Shipbuilding", *Bulletin of the Australian Institute of Maritime Archaeology* 17.1, 9–16.

[112] Personal communication with Maizan Hassan Maniku, 1997.

[113] Personal communication with Horst Liebner, 2013.

In any event, the edge-dowelling of planks to assemble the plank-shell is not a feature of the Indian or Arabian boat building traditions which Maldivian boat building might be expected to resemble on grounds of cultural and geographic propinquity.

The planks of Maldivian boats are fitted in matched opposing pairs—port and starboard—each plank is shaped in conjunction with a mirror image plank for the opposite side of the hull. Before fitting, each plank is pre-bent to approximately the right shape using heat. The roughly shaped plank is offered up (trial fitted) using loose, undersized dowels to hold it in place while it is marked for a more exact fit. These procedures are precisely the same in Western Indonesia and a very similar spiling gauge is used to mark the planks. In Eastern Indonesia, a similar procedure is followed except that grown planks are carved to shape rather than bent to shape.

Like some of the more traditional Southeast Asian vessels, Maldivian vessels are built up from a keel that can be seen as a vestigial dugout canoe on the basis of its shape. Some Southeast Asian vessels were actually built up from a dugout canoe-keel.

The hulls of Maldivian vessels are strengthened by numerous thwarts and beams arranged in vertically aligned groups (Fig. 6.12f). Similar structures are widely known in a range of archaic Indonesian vessels. In simple types of planked up dugout canoes the thwarts are either let into the planks and dugout base, or they are secured against carved lugs on the inside of the dugout and the planks, and the thwarts are lashed to each other vertically so as to hold together the planks and the dugout base. In more developed planked vessels, such as the Madurese golekan, the thwart-beam structures are not lashed to hold the planks of the hull together, but serve in place of frames or bulkheads to stiffen the hull. They also serve to step the mast and a tall spar-crutch pole in the stern.

There were, in the past, designs which combined the use of multiple thwart-beam structures with the use of framing timbers—floors, bilge futtocks and top futtocks, which in most cases were non-contiguous (not articulated). The older and more traditionally constructed Maldivian craft had a similar combination of thwart-beam structures and framing timbers which were non-contiguous. A photograph from the late 1950s shows Maldivian boats with tiers of beams arranged to form solid bulkheads and only light frame timbers.[114]

[114] Stanley E. Bradfield (1964) *Road to the Sea* (London: Temple Press Books), Fig. 17.

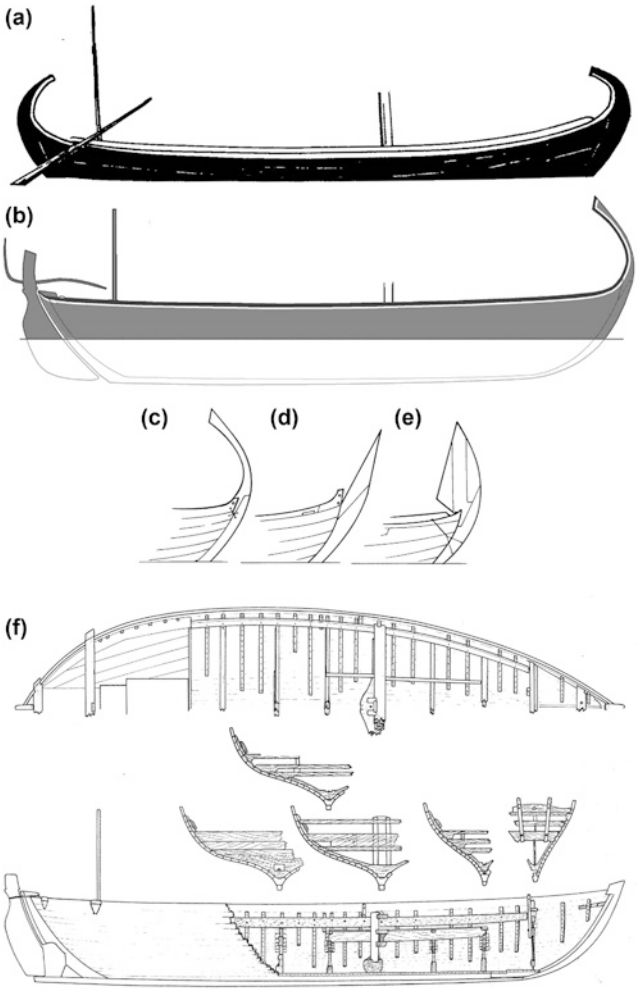

Fig. 6.12 Comparison of Maldivian dhoni and Javanese mayang: (a) a mayang from West Java (traced from a photograph); (b) a Maldivian mas dhoni; (c) the bow of a mas dhoni showing the recurved prow or stemhead, socketed between stem and hull planking and stitches fastening the stem to the hull planking; (d) bow of a Madurese perahu lete showing similar structure; (e) East Javanese mayang with stitching of the stem to the hull to support the weight of the prow; (f) construction detail of a motorised dhoni drawn from data collected by a Western Australian Maritime Museum team

The thwarts and beams in Maldivian vessels are secured to the hull with fastenings and restrained from movement forward and aft by carved lugs projecting from the inside of the hull planks. There are also carved lugs forward and aft of the heavy floor timber that forms the mast step. The use of carved lugs on the inside of the planking of Southeast Asian craft is well documented.[115] In most cases, the lugs are pierced to take lashings which secure frames, beams, or both frames and beams—the so-called lashed-lug construction technique. In relatively simple canoes, lugs are often employed to restrain beams, thwarts and outrigger booms against both vertical and horizontal movement. However, lugs which restrain thwarts or beams against horizontal movement only (as they are designed to do in Maldivian vessels) are almost unknown in Southeast Asian design. There are traditional planked canoes from Botel Tobego, Taiwan (built by the Malayo-Polynesian indigenes) which have continuous longitudinal ribs on the inside of the planking rather than a series of lugs, and these ribs are checked in the bow and stern to secure frames against fore-and-aft movement. It is possible that the structure of the thirteenth-century vessels excavated at Butuan in the Philippines included a similar arrangement.

In the bow and stern of the *dhoni* shown in Fig. 6.12 there are thwarts let into the planking with half dovetails on the forward and aft faces respectively. These thwarts help tie together the ends of the hull. In the bow, the thwart is let into the strake below the sheer strake or wash strake, but it does not actually pierce the plank. To accommodate the thwart, the plank is made considerably thicker than the other planks and is an irregular pentagon in its sectional shape forming a ledge or rail on the inside of the hull. The thwart in the stern is let through the sheer strake and it projects slightly where it pierces the planking. More or less identical structural details are found on most Javanese *mayang* (Fig. 6.12). In the *mayang*, the heavy pentagonal sectioned strake below the wash strake is carried right through the length of the hull and in some cases serves as a beam shelf. On the Maldivian vessel surveyed at Male, there is a separate beam shelf fitted as a stringer on the inside of the top futtocks. The thickening of the strake is only in the bow. But it is

[115] Carl A. Gibson-Hill (1952) "Further Notes on the Old Boat Found at Pontian", 111–133; G. Adrian Horridge (1978) *The Design of Planked Boats of the Moluccas*, for example.

quite likely that formerly the thickened strake was carried right through the length of the vessel, as it is in the *mayang*, particularly if frames were a less important part of the structure of Maldivian vessels (frames gradually replaced thwart-beam structures in the twentieth century). In both *dhoni* and *mayang* the upper frame timbers end below sheer strake.

The large Maldivian fishing vessels called *mas dhoni* have tall recurved prow-pieces fitted to extend the stem. Tall recurved prows are the most salient characteristic of Javanese *mayang* and serve to identify *mayang* in iconography dating back to the sixteenth century.[116] On both *mayang* and *mas dhoni,* the prow piece is socketed between the top of the stem and the forward end of the upper hull planking. The ends of the upper strakes are not fastened to the stem, but they are tied together by the thwart described above. On the *mas dhoni* the upper part of the stem is secured to the hull, against the weight of the prow, by lashings which pass through the planking: One type of *mayang*, the *jangraja* of East Java, has a similar lashing of the stem to the hull planking (Fig. 6.12).

Both *mayang* and *mas dhoni* have their mast stepped into heavy floor timbers rather than longitudinal mast steps laid on top of the floors.

In the stern of the *dhoni* in Fig. 6.12, there are two projecting thwarts, the upper one is let into the sheer strake. This thwart is used to secure, by lashings, a removable aft platform-deck. It also serves to step a tall spar-crutch post. Many types of Southeast Asian craft have one or two projecting beams in the stern, and in most cases, they serve to mount the quarter rudders, often they also support an aft platform-deck and the spar-crutch structure. Maldivian vessels have median rudders hung on the sternpost rather than quarter rudders, but it is reasonable to assume that quarter rudders were once standard in the Maldives as they were in the rest of the Indian Ocean, and the slight projection of the beams in the stern may be indicative of their former rudder mounting function. Javanese *mayang* do retain quarter rudders, and also have one or two slightly projecting beams in the stern, but, curiously, their quarter rudders are not now mounted on the projecting beams. The function of the beams is to step the tall spar-crutch post. This tall single pole spar-crutch, stepped on the centre line of the hull, is another identifying characteristic of Javanese vessels that is shared by Maldivian

[116] Nick Burningham and Kurt Stenross (1994) "Mayang: The Traditional Fishing Vessel of Java", *The Beagle: Records of the Museums and Art Galleries of the Northern Territory* 11, 73–132.

vessels but not other Southeast Asian vessels. Double spar-crutch posts mounted on the quarters are common through much of the rest of Indonesia while the traditional vessels of peninsular Malaysia have a single post stepped on the rail and inclining outboard. On the *mayang* and the *dhoni*, a pole slung between the spar-crutch and the mast can be used to hang and dry nets.

Although there are several clear similarities between *mayang* and *dhoni*, they are different in their basic hull forms. While the *dhoni* have hollow deadrise flowing through slack bilges into flared topsides, *mayang* have very little deadrise and show distinct chines in the midsection. *Mayang* are shallow drafted fishing vessels that probably retain structural and stylistic features that were once shared by larger deep-sea-going cargo vessels from Java and neighbouring islands. There are vessels further east in Indonesia with similar hull form to the *mas dhoni*: The *sope* of the Bajo people and the *kululis* of the Kei Islands show hull sections similar to the Maldivian *dhoni*, the *kululis* also show similar rounded profile in the bow and stern.

The similarities in basic structure and hull form between the boatbuilding of the Maldives and some Southeast Asian examples suggest the possibility of a communication of technology at sometime in the past, perhaps as early as the Indonesian migration to Madagascar; but the similarities of style and detail with Javanese *mayang* suggest a more recent period of well-developed communication with Java.

Tomé Pires (1465?–1524 or 1540) in his early sixteenth-century *Suma Oriental* noted that the Sundanese (West Java) brought slaves from the Maldives "because they can get from Sunda to the Maldive Islands in six or seven days".[117] This is implausibly fast. Two weeks would be a good passage from Sunda Strait to the Maldives.

Alexander Hamilton in his *A New Account of the East Indies* noted that the Maldives exported cowrie shells to Bengal and dried fish (bonito) to Aceh, Sumatera: "Ships come from Atcheen on the Island of Sumatra, and purchase them [dried fish] with Gold Dust". He also noted that the Maldiveans built "vessels of 20 or 30 Tuns. Their Hulls, Masts, sails, Rigging, Anchors, Cables, Provisions and Firing are all from this useful [coconut] Tree […]".[118]

[117]Tomé Pires [1465?–1524/1540] (1944) *Suma Oriental*, trans. and ed. Armando Cortesão, vol. 2 (London: Hakluyt Society), 169.

[118]Alexander Hamilton [Seventeenth–Eighteenth Century] (1744) *A New Account of the East Indies* (London: Hitch & Millar), 350.

Dhonbeefaanu Vaahaka, a novel by the Maldivian novelist and politician Hussain Salaahuddin describes the traditional way of life of a Maldivian family with trade connections with Indonesia in the first half of the twentieth century.

Were Maldivian vessels formerly of sewn-plank construction? Ma Huan, who visited the Maldives in 1413 and 1421, says "they never use nails, they merely bore the holes and always use their rope to bind together, employing wooden pegs in addition […]".[119] This is ambiguous because it could refer to the assembling of the plank-shell or the fitting of the frames to the plank-shell. Correa who visited the Maldives in 1513 says the vessels "were made of coconut timbers assembled with wooden pegs […]".[120] Sewn-planks would have been visible and would probably have been mentioned by Correa if he observed them.

[119]Ma Huan 馬歡 [c. 1380–1460] (1970) *Ying-yai Sheng-lan* 瀛涯勝覽—*'The Overall Survey of the Ocean Shores'*, ed. Feng Ch'eng-chün 馮承鈞 [1885–1946], trans. John V. G. Mills [Hakluyt Society Extra Series, 42] (Cambridge: Cambridge University Press, reprint of 1433).

[120]Gaspar Correa (1858) *Lendas da India* (English Translation), vol. 2, 103.